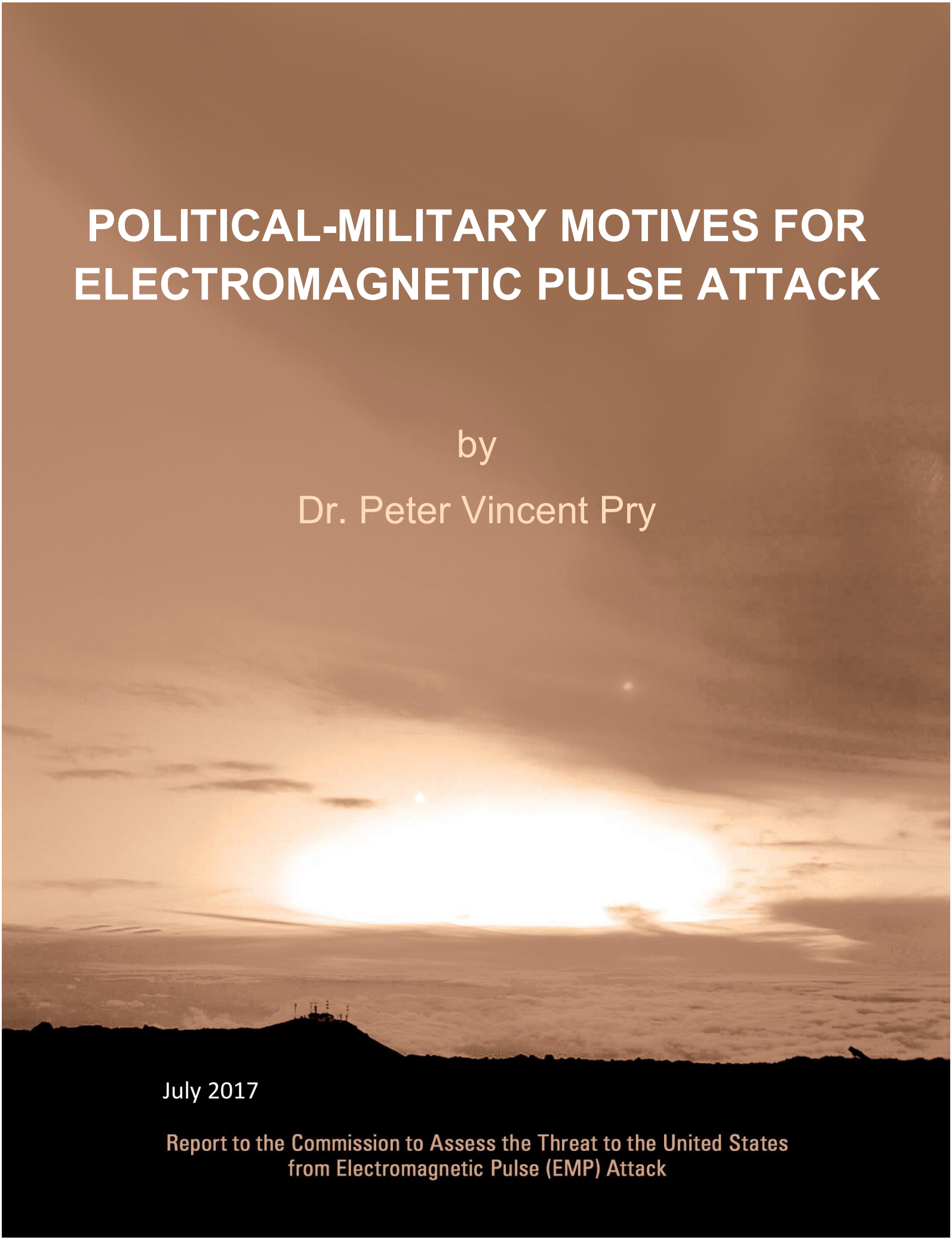

POLITICAL-MILITARY MOTIVES FOR ELECTROMAGNETIC PULSE ATTACK

by

Dr. Peter Vincent Pry

July 2017

Report to the Commission to Assess the Threat to the United States
from Electromagnetic Pulse (EMP) Attack

REPORT TO THE COMMISSION TO ASSESS THE THREAT TO THE UNITED STATES
FROM ELECTROMAGNETIC PULSE (EMP) ATTACK

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This paper was drafted to inform the work of the EMP Commission during 2001-2008, but could not be published because the Commission was terminated before Staff Papers could be submitted for security classification review. It is offered now for completeness of the analytical record.

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The cover photo depicts Fishbowl Starfish Prime at 0 to 15 seconds from Maui Station in July 1962, courtesy of Los Alamos National Laboratory.

This report was produced to support the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack. The Commission was established by Congress in the FY2001 National Defense Authorization Act, Title XIV, and was continued per the FY2016 National Defense Authorization Act, Section 1089.

The Commission completed its information-gathering in June 2017. The amended report was cleared for open publication by the DoD Office of Prepublication and Security Review on July 11, 2018.

This report is unclassified and cleared for public release.

Acronyms and Abbreviations

CBRNE	chemical, biological, radiological, nuclear, and enhanced high explosive
CONUS	continental United States
DNA	Defense Nuclear Agency
EMP	electromagnetic pulse
HEMP	high-altitude electromagnetic pulse
ICBM	intercontinental ballistic missile
NATO	North American Treaty Organization
NIE	National Intelligence Estimate
NIPP	National Institute for Public Policy
NSSQ	National Security Studies Quarterly
QDR	Quadrennial Defense Review
WMD	weapons of mass destruction

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Key Judgments

The locus of the United States concerns about possible missile threats has shifted away from the now defunct Soviet Union toward terrorists and their rogue state sponsors, who constitute an imminent threat to the United States and its allies. Deterrence of terrorists and rogue states, whose values and thinking are little understood in the West, poses an unprecedented challenge. Indeed, the surprise failure of deterrence has become more likely. China and Russia are unpredictable and remain nations of concern, if only because of their nuclear missile capabilities, that still constitute a potential threat. Moreover, evolving Russian and Chinese military doctrine contemplates the theoretical possibility of limited nuclear war, including electromagnetic pulse (EMP) attack.

State or non-state actors that possess, or that could acquire, missiles armed with nuclear weapons may well calculate that in a crisis the greatest political-military utility can be obtained from their use, or threatened use, in an EMP attack. A nuclear weapon detonated at high altitude could damage or destroy electronic systems within a radius of hundreds or thousands of kilometers on the Earth's surface. A high-altitude nuclear burst for EMP will also produce other effects that could destroy satellites, and cause blackout and scintillation, that could impede or prevent radio communications.

An EMP attack against the United States' homeland could damage or destroy computer networks, telecommunications, transportation, and power grids that are vital to the economy and society, and for the sustenance of life. A single nuclear weapon could conceivably make an EMP attack that would place at risk the vital civilian infrastructure in several states, and even across the entire continental United States.

An EMP attack against U.S. military forces could damage or destroy: command, control, and communications (C3); satellites, surveillance, and intelligence networks; missiles, aircraft, and other sophisticated electronic systems that are the vital core of the United States' military, and are indispensable to U.S. superiority on the battlefield. A single nuclear weapon could conceivably be employed to make an EMP attack that would place at risk U.S. and allied military forces across an entire theater.

An EMP attack would probably cause relatively few or no prompt fatalities, raising the possibility that the United States might not respond with massive retaliation. Albeit, in some extreme scenarios, an EMP attack that causes the complete and protracted collapse of the United States' electronic infrastructure could eventually, over months or years, inflict indirectly millions of fatalities. Nonetheless, it is more plausible that an EMP attack would be less provocative of U.S. massive retaliation than a nuclear attack that promptly incinerates a U.S. city or military base, compelling an immediate U.S. response.

An EMP attack is also likely to be less provocative of U.S. massive retaliation than a missile attack employing biological or chemical weapons that inflicts large numbers of casualties

on a U.S. city or military base. Compared to missile attack options employing nuclear blast, biological, or chemical weapons of mass destruction, EMP attack is virtually unique in that it is least likely to provoke U.S. massive retaliation, while promising to be the option most militarily effective.

Strategically and politically, a capability for EMP attack is among the most credible weapons of mass destruction (WMD) threats for deterrence or blackmail because it would attack electronics, not people. In contrast to the limited effect radius of other WMD options, EMP can threaten entire regional or national infrastructures that are vital to U.S. military strength and societal survival, or challenge the integrity of entire allied coalitions. EMP attack would likely pose a retaliatory dilemma for the United States, since EMP is an asymmetrical threat, more dangerous to the electronically advanced West than to underdeveloped Third World rogue states.

EMP is also a force multiplier that, if used in conjunction with other WMD options, would probably greatly increase their effectiveness.

Technical and operational reasons also favor an EMP attack over other attack options employing nuclear, biological, or chemical weapons. EMP attack can compensate for technical and operational problems associated with missile reentry vehicle design, fusing, accuracy, range, intelligence on target location, collateral damage, and missile defense penetration.

Numerous plausible scenarios exist for an EMP attack against the United States. During a conflict in the Asian, Middle Eastern, or European theater, an adversary might make an EMP attack against U.S. military forces located in the theater of operations in order to gain a military advantage, or at least to "level the battlefield" by negating the United States' high-tech superiority. An adversary might make an EMP attack on U.S. society in a bid to break the United States' political will to continue a war, or to deny the U.S. victory by making the cost exceed the value of winning, or merely to exact revenge. An adversary concerned that his missiles could be intercepted by missile defenses might “salvage fuse” his nuclear weapons to detonate in the event of interception, generating an EMP that could potentially damage U.S. missile defenses. U.S. forces or assets could suffer from an EMP attack, or from its coincident effects, inadvertently, as a consequence of a war between other parties, such as India and Pakistan or Iran [redacted].

The EMP Threat Then and Now

During the Cold War, when most EMP research and protection measures were undertaken, the commonly assumed scenario for an EMP attack was in the context of a large-scale nuclear war with the Soviet Union. It was assumed that the Soviet Union would launch an EMP attack as a precursor strike that would damage the United States' command and control and impede U.S. capabilities to retaliate. The EMP attack would be followed immediately by a large-scale nuclear attack by the bulk of Soviet forces that would try to blast U.S. missiles, aircraft, and command centers before they could recover from the EMP precursor.[1]

Under this scenario, massive unavoidable collateral damage to U.S. civilians and the civilian infrastructure was expected, even if extraordinary efforts were made to protect U.S. civilians and the infrastructure from attack. Since the objective of a Soviet EMP attack was to damage U.S. nuclear and military forces, the United States Government judged that the best way to protect U.S. civilians and infrastructure was to protect U.S. forces from EMP and other nuclear effects, and so deter a Soviet attack.

Accordingly, during the Cold War, the United States invested heavily in research into EMP effects and developing means of protection against EMP. Most of these efforts were primarily centered on hardening military systems. Strategic nuclear forces and C3 received the most EMP hardening because of the critical nature of these systems, and the virtual certainty that they would be exposed to EMP in a nuclear war, and the requirement that strategic forces operate with high reliability in the most hostile possible environment.[2]

General purpose forces and their C3 also received some EMP hardening, although significantly less than that accorded strategic forces. General purpose forces, it was assumed, would more likely operate in a non-nuclear environment. Moreover, the cost of hardening general purpose forces to the same level as strategic forces was considered prohibitive.

Compared to research and analysis of the potential vulnerability of military systems to an EMP attack, the U.S. Government has dedicated much less attention to the potential threat from EMP to the United States' economy and society. Most of the United States' civilian infrastructure—the economy, transportation, and utilities—are unprotected against EMP because of the assumed futility and formidable costs associated with such an undertaking in the face of a massive nuclear attack, such as was threatened by the Soviet Union.

However, today, the locus of the United States' concerns about possible missile threats has shifted away from the now defunct Soviet Union toward terrorists and their rogue state sponsors, who constitute an imminent threat to the United States and its allies. China and Russia are

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1 See for example: John Steinbruner, "Launch Under Attack," **Scientific American** (January 1984), p. 39. Defense Nuclear Agency, P. Dittmer et al., **DNA EMP Course Study Guide**, DNA-H-86-68-V1 (Washington, D.C.: BDM Corporation for Defense Nuclear Agency, 27 May 1986), pp. 20-21, 54-57.

2 Jonathan B. Tucker, "Strategic Command and Control: America's Achilles Heel?," **Technology Review** (August/September 1983), p. 44. Daniel Ford, **The Button: The Pentagon's Strategic Command and Control System** (New York: Simon and Schuster, 1985), p. 160.

unpredictable and remain nations of concern, if only because of their nuclear missile capabilities, that still constitute a potential threat.[3]

In the post-Cold War world, where the United States is the sole superpower, are concerns about EMP and other WMD threats exaggerated, since U.S. military strength—that successfully deterred the U.S.S.R. during the Cold War—should still deter the lesser threats of today?

How well deterrence worked against the Soviet Union during the Cold War, and against Russia afterward, is controversial. Some recent scholarship suggests that nuclear deterrence has come close to failing more often and more recently than previously believed. For example, some analysts have described Russia's nuclear alert in January 1995, in mistaken response to false warning triggered by a Norwegian meteorological rocket, as the single most dangerous incident of the nuclear missile age. Other lesser known brushes with nuclear deterrence failure include Soviet overreaction to a 1983 NATO theater nuclear exercise, ABLE ARCHER-83; Moscow's nuclear alert during the August 1991 coup attempt against then Soviet President Mikhail Gorbachev; the October 1993 coup attempt against then Russian President Boris Yeltsin; and perhaps Russian overreaction to NATO's first war, against Yugoslavia, in 1999. On May 28, 1999, former Russian Prime Minister Viktor Chernomyrdin, an envoy to negotiations with NATO over the Yugoslav crisis, declared, "The world has never in this decade been so close as now to the brink of nuclear war." A few weeks earlier, on May 2, 1999, a delegation from the Russian Duma meeting in Vienna with a delegation from the U.S. Congress threatened that the war in Yugoslavia could lead to a Russian EMP attack on the United States.[4]

Perhaps deterrence worked during these incidents, but luck also appears to have played a large role in the avoidance of nuclear war.

A January 2001 study, Rationale and Requirements for U.S. Nuclear Forces and Arms Control from the National Institute for Public Policy (NIPP), that is widely credited with providing the doctrinal basis for the Bush Administration's policy on nuclear sufficiency and arms control, concludes the following about nuclear deterrence:

- "The new features of the post-Cold War period greatly magnify the challenges of deterrence. The post-Cold War international environment holds out a much wider variety of potential opponents and contexts in which U.S. deterrence policies must operate. And, far less is known about several potential challengers, including North Korea for example, than was known about the Soviet Union. Consequently, the scope is much greater for potential challengers' unfamiliar or idiosyncratic factors to shape responses to U.S. deterrence policies in surprising directions."

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[3] Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack," **Floyd D. Spence National Defense Authorization Act For Fiscal Year 2001**, Report 106-616, Title XIV (Washington, D.C.: U.S. Government Printing Office, May 12, 2000), p. 432.

[4] Peter Vincent Pry, **War Scare: Russia and America on the Nuclear Brink** (Westport, Connecticut and London: Praeger, 1999), passim, Duma and Chernomyrdin quoted on p. 285. Central Intelligence Agency, Ben B. Fischer, **A Cold War Conundrum: The 1983 Soviet War Scare**, CSI 97-10002 (Center for the Study of Intelligence, September 1997).

- "There is ample evidence that Washington is much less familiar with the variety of factors that could be significant in rogue leadership decision-making than it was with Soviet decision-making. This lack of familiarity will greatly challenge Washington's capacity to understand a rogue challenger's cost-benefit calculus, and thereby devise deterrence policies likely to succeed.
- "Rogues, similarly unfamiliar with Washington, may easily misread U.S. intentions and actions, and thereby reduce the prospects for deterrence."
- "Confident generalizations about the effectiveness of deterrence should wane with greater recognition that diverse leadership characteristics and beliefs can move rational decision-makers in surprisingly unreasonable directions, and deterrence can fail as a result. Regardless of how well-informed U.S. deterrence policy may be, it is important to acknowledge that deterrence can fail for a variety of potential reasons: desperate leaders driven by an internal or external imperative may distort reality in a self-serving fashion, they may be inattentive, foolish, or simply so cost/risk tolerant in pursuit of a particular goal that U.S. deterrence policy is impracticable."

The NIPP study also concludes, "The surprise failure of deterrence has become more likely. And, with the proliferation of WMD, a single surprise could easily lead to hundreds of thousands, even millions, of American casualties."[5]

If the surprise failure of deterrence has become more likely in the post-Cold War world, the character of the nuclear threat has also changed.

Terrorists and emerging nuclear missile states like North Korea and Iran are not expected to acquire missiles and nuclear weapons in sufficient numbers or sophistication to threaten the retaliatory capabilities of the United States' strategic nuclear forces. Only Russia and perhaps China are expected to pose such a threat. The nuclear missiles deployed, being developed, or potentially available for acquisition by terrorists and rogue states are much better suited for threatening U.S. general purpose forces than strategic forces, and are still better suited for attacking U.S. civilians. Moreover, evolving Russian and Chinese military doctrine increasingly contemplates the theoretical possibility of limited nuclear war where, instead of a massive nuclear attack, small-scale or single nuclear strikes would be performed.[6] EMP attack is an oft discussed topic in current Russian and Chinese military literature.

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[5] National Institute for Public Policy, **Rationale and Requirements for U.S. Nuclear Forces and Arms Control**, Vol. 1 (Fairfax, Virginia: January 2001), p. 11. See also: Keith B. Payne, **Deterrence in the Second Nuclear Age** (University of Kentucky Press, 1996). Keith B. Payne, **Post-Cold War Requirements for U.S. Nuclear Deterrence Policy** (Fairfax, Virginia: National Institute for Public Policy, March 1998).

[6] Pry, op. cit., chapter 33. See for example: Aleksandr Shirokorad, "A Small Bomb for a Small War: The Role of Tactical Nuclear Weapons Is Objectively Increasing As Strategic Forces Are Reduced," **Nezavisimaya Voyennoye Obozreniye** (10 April 1998). Colonel V. V. Kruglov and Colonel M. Ye Sosnovskiy, "Nonstrategic Weapons in Nuclear Deterrence," **Military Thought** (September 1997), pp. 11-14. David Hoffman, "Yeltsin Approves Doctrine of Nuclear First Use If Attacked," **Washington Post** (10 May 1997). Yoshihisa Furumori, "Signs of Change in Chinese Nuclear Strategies," **Sankei Shimbun** (Tokyo: 6 August 1999). Hoa Tien, "Thorough Disclosure of the Inside Story of Chinese Military Maneuvers," **Hong Kong Kuang Chiao Ching** (16 October 1999).
53. "Great Wall Project Said to Deter Taiwan Independence," **Sing Tao Jih Pao** (Hong Kong: 26 November 1999), p. A17.

An adversary armed with one or a small number of nuclear missiles is likely to calculate that the United States can most effectively be damaged, or blackmailed, through the use, or threatened use, of their modest nuclear arsenal in an EMP attack. An adversary weighing limited nuclear options is likely to calculate that the most, or among the most, attractive options for limited nuclear war is EMP attack.

The growing dependence of the United States' society and military on electronic systems—indeed, the centrality of these systems to the social-economic fabric and military power of the United States—has led many foreign analysts to conclude that the most effective threat against the United States is EMP attack.

Alistair Iain Johnson, "China's New Old Thinking: The Concept of Limited Deterrence," **International Security** (Winter 1995-96), p. 28. Ehsan Ahrari, "China Changes Its Strategic Mindset," **Jane's Intelligence Review**, Part 1 (November 1999), pp. 39-44 and Part 2 in **Jane's Intelligence Review** (December 1999), pp. 30-35.

EMP Threat to the U.S. Civilian Infrastructure

As the United States' civilian infrastructure becomes increasingly dependent on ever more sophisticated electronic systems, that infrastructure also becomes potentially more vulnerable to an EMP attack.

The United States' society has been transformed by increasingly pervasive and sophisticated electronic systems at all levels of government, the private sector, and in the lives of individual citizens. To name just a few examples, the Internet, cellular telephones, and personal computers are technologies that were unknown or scarcely available to the general public 20 years ago. These electronics are now commonplace and have transformed society, becoming indispensable to the United States' economic, political, and social fabric.

The United States owes its prosperity to increasingly sophisticated electronic systems—satellites, telecommunications, computers, data processing and storage—that have revolutionized business and created a global economy, largely managed in the United States. Many economists credit the electronics revolution with transforming the United States from an industrial economy, based on manufacturing, to a "post-industrial" or "information-based" economy. Many economists and social scientists foresee the future economic prosperity and social development of the United States as directly linked to a continuing electronics revolution that will foster ever greater U.S. reliance and dependency on increasingly sophisticated and integrated electronic networks.[7]

Communications depend upon satellites, radio, telephone long lines, and signal processing centers that could be damaged or destroyed by EMP or other effects from a high-altitude nuclear burst. Business and government are critically dependent upon data processing and storage systems that make possible banking and basic transactions involving wealth and recordation, without which modern economies and governments cannot function.

Transportation depends upon aircraft, air traffic control systems, and navigation aids that could be damaged or destroyed by an EMP attack. Ground transportation relies upon a myriad of command, control, and dispatch systems, including traffic lights. Most vehicles have electronic components that may be vulnerable to EMP. As traffic jams daily demonstrate, even small failures in transportation systems can have cascading effects that produce complete paralysis.

Power depends on electric long lines that are particularly good receivers for electromagnetic energy. Power lines have been known to fail catastrophically due to geomagnetic storms that pose a much smaller threat than EMP attack. In 1989, a geomagnetic

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[7] Daniel Bell, **The Coming of Post-Industrial Society: A Venture in Social Forecasting** (New York: Basic Books, 1999). Manuel Castells, **The Rise of the Network Society** (Blackwell Publishers, 2000), see esp. chapter 2. Nicholas Negroponte, **Being Digital** (New York: Vintage Books, 1995). Jerry L. Salvaggio (ed.), **The Information Society: Economic, Social, and Structural Issues** (Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1989). Alvin Toffler, **The Third Wave** (New York: William and Morrow, 1980).

storm caused a widespread power outage in Quebec that was in Canada considered a national emergency, requiring redesign and reconstruction of the Quebec power grid. Water, food storage and distribution depend upon electric power. An EMP attack that causes protracted failure of electric power systems over a large region, across several states or the entire United States, could potentially threaten the lives of millions.

The report **HEMP Effects on Industry** by the U.S. Defense Nuclear Agency (1987) is one of the few unclassified attempts by the U.S. Government to provide a net assessment of the vulnerability of the U.S. industrial infrastructure to EMP attack. The DNA report drew the following conclusions:

- "Industry is not prepared to cope with large-scale, wide-area failures. Consider, for example, the possibility of losing electrical power across the nation for several hours (not so far-fetched in an HEMP scenario). Not only would the loss of production be significantly disruptive…but the loss of financial transaction data (some $400 billion a day) that supports the industrial economy could be disastrous. The requirements for public safety, sanitation, and protection would be seriously effected by such a power loss and the resulting communications failures."
- "Based on the industry data developed in this project, HEMP damage to semiconductor electronics seems highly likely considering the thresholds of the devices used, the lack of protection in place, and reasonable estimates of the transient voltage and current levels."
- "The U.S. industrial base relies on a small set of vital products and services without which it is virtually impossible to operate. These vital items are water, transportation, electricity, and communications…A comparison of current problems experienced in normal operations with postulated effects from HEMP produces cause for concern. The additional problems generated by HEMP will result from its simultaneous and broad geographic effects on integrated systems, e.g., the tripping of power system units and the loss of major loads through possible computer failure."
- "Collateral effects of HEMP interaction may include explosions in the industrial plants and storage areas from loss of control of the production system or robotic warehouse equipment….Another, albeit less likely, outcome is the possible release of radioactive material from the inspection equipment."
- "Given the simultaneous tripping of control rooms and generators…it will only take several seconds before the [electrical power] system comes to an abrupt halt…Electrical grid problems are more difficult to define because the system is designed with some protective features. Yet the extent of protection within the HEMP bandwidth is uncertain….Unfortunately, the electric power system connects the entire U.S., albeit weakly, into a giant electromagnetic antenna."
- "On the positive side, hydroelectric generation capability would probably be least effected by HEMP. The hydro plants can be manually restarted (since the fuel relies on

gravity for delivery) and the systems are the least influenced by frequency sensitivities on transmission lines."

The DNA report concludes, "The lack of any substantial protection makes the industrial base highly susceptible to HEMP. It has been demonstrated that HEMP can and will affect unprotected electronic equipment. The data available in the open literature and the data collected under this assessment would certainly justify a pessimistic evaluation."[8]

[8] Defense Nuclear Agency, J. R. Labadie, R. M. Mason and M.S. Wilson, **HEMP Effects on Industry**, DNA-TR-86-79 (Washington, D.C.: IRT Corporation, 2 February 1987), passim.

EMP Threat to the U.S. Military

The EMP threat to the U.S. military may be greater today and in the future than during the Cold War.

The proliferation of missiles and nuclear weapons is increasing the number of actors who could perform an EMP attack. According to the unclassified summary of the National Intelligence Estimate **Foreign Missile Developments and the Ballistic Missile Threat Through 2015** (December 2001):

> *Most Intelligence Community agencies project that before 2015 the United States most likely will face [intercontinental ballistic missile] ICBM threats from North Korea and Iran, and possibly from Iraq…in addition to the longstanding missile forces of Russia and China….Short- and medium-range ballistic missiles already pose a significant threat overseas to U.S. interests, military forces, and allies….Several countries could develop a mechanism to launch SRBMs, MRBMs, or cruise missiles from forward-based ships or other platforms: a few are likely to do so—more likely for cruise missiles—before 2015…Foreign nonstate actors—including terrorist, insurgent, or extremist groups that have threatened or have the ability to attack the United States or its interests—have expressed an interest in chemical, biological, radiological, or nuclear (CBRN) materials.*[9]

According to the National Intelligence Estimate (NIE), the odds that a missile with a weapon of mass destruction will be used against the United States are greater today than during most of the Cold War.[10]

The Department of Defense's **Quadrennial Defense Review** Report (QDR) of September 30, 2001, concurs that the threat to the United States from missiles and weapons of mass destruction is increasing. The QDR also cautions that the intelligence community has been surprised, and may be surprised again, by the speed of the emerging threat from missiles and WMD:

> *It is clear that over time an increasing number of states will acquire ballistic missiles with steadily increasing ranges….many seek to acquire—or have acquired—chemical, biological, radiological, nuclear, and enhanced high explosive (CBRNE) weapons. These states are developing ballistic missile capabilities, supporting international terrorism….The pervasiveness of proliferation in an era of globalization has increased the availability of technologies and expertise needed to create the means to directly challenge the*

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[9] National Intelligence Council, **Foreign Missile Developments and the Ballistic Missile Threat Through 2015** (Central Intelligence Agency: National Intelligence Estimate, December 2001), pp. 3-4. Hereinafter NIE (December 2001).

[10] Ibid, p. 7.

United States and its allies and friends….In particular, the pace and scale of recent ballistic missile proliferation has exceeded earlier intelligence estimates and suggests these challenges may grow at a faster pace than previously expected….Together, these military- technical trends create an increased potential for miscalculation and surprise. In recent years, the United States has been surprised by the speed with which other states have progressed in developing weapons of mass destruction and ballistic missiles.[11]

While the proliferation of missiles and nuclear weapons increases the possibility of an EMP attack, the potential effectiveness of such an attack is also increasing because modern electronics are inherently more vulnerable to EMP. During the HEMP tests of the early 1960s, electronics were based on vacuum tube and transistor technology that is thousands of times less susceptible to EMP than modern semiconductors, the basis of electronics today. In general, as electronics become more miniaturized and achieve higher circuit density, they become more vulnerable to EMP. An EMP that caused a temporary upset in a 1960s transistor might destroy a modern computer chip.

The United States' military power is based upon increasingly sophisticated electronic systems that may be increasingly vulnerable to EMP attack.

Official U.S. policy, known as "Transformation," aims at preserving U.S. military superiority over potential enemies through superior electronic battle management systems. "Transformation" seeks a revolutionary improvement in the capabilities of all the military services, so that wars can be fought more efficiently, with far fewer forces and personnel actually present on the battlefield. Electronic dependency will grow as the U.S. military implements its plans to transform itself into a force that will dominate the battlefield through advanced electronic surveillance, telecommunications, and data processing systems.[12]

Vice Admiral Arthur Cebrowski, head of the Office of Transformation in the Department of Defense, in a February 2002 interview described transformation as "The emergence of sensor-based warfare…The sensor has moved to a position of primacy." Cebrowski also coined the phrase "network centric warfare" to describe transformation as the emergence of new military capabilities from more advanced and better integrated communications and information systems.[13]

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[11] Secretary of Defense, Donald H. Rumsfeld, **Quadrennial Defense Review Report** (September 30, 2001), pp. 3, 4, 6, 7. Hereinafter **QDR**.

[12] Department of Defense, "Secretary of Defense Rumsfeld Speaks on '21st Century Transformation' of U.S. Armed Forces," transcript of speech delivered at National Defense University, Fort McNair, Washington, D.C. (31 January 2002). Frank Tiboni, "U.S. DoD Transformation Office to Focus on Five Areas," **Defense News** (11 February 2002).

[13] Nathan Hodge, "Transformation Boss Sees 'Sensor-Based Warfare' Era," **Defense Weekly Daily Update** (5 February 2002).

The Joint Staff's Joint Vision 2020 (June 2000) describes key aspects of the U.S. military of the future, transformed by the revolutionary application to battle management of advanced electronics:

- "Information Superiority. Information, information processing, and communications networks are at the core of every military activity….the ongoing 'information revolution' is creating not only a quantitative, but a qualitative, change in the information environment that by 2020 will result in profound changes in the conduct of military operations."
- "Precision Engagement is the ability of joint forces to locate, surveil, discern, and track objectives or targets; select, organize, and use the correct systems; generate desired effects; assess results; and reengage with decisive speed…as required, throughout the full range of military operations."
- "Focused Logistics is the ability to provide the joint force the right personnel, equipment, and supplies in the right place, at the right time, and in the right quantity, across the full range of military operations. This will be made possible through a real-time, web-based information system providing total asset visibility as part of a common relevant operational picture, effectively linking the operator and logistician across Services and support agencies."[14]

According to the QDR, "Six critical operational goals provide the focus for the DoD's transformation efforts." All or most of these goals specifically depend upon advanced electronic systems that could be threatened by EMP attack:

- "Protecting critical bases of operations (U.S. homeland, forces abroad, allies, and friends) and defeating CBRNE weapons and their means of delivery;"
- "Assuring information systems in the face of attack and conducting effective information operations;"
- "Projecting and sustaining U.S. forces in distant anti-access or area-denial environments and defeating anti-access and area-denial threats;"
- "Denying enemies sanctuary by providing persistent surveillance, tracking, and rapid engagement with high-volume precision strike…against critical mobile and fixed targets…in all weather and terrains."
- "Enhancing the capability and survivability of space systems and supporting infrastructure; and"
- "Leveraging information technology and innovative concepts to develop an interoperable, joint C4ISR architecture and capability that includes a tailorable joint operational picture."[15]

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[14] Joint Chiefs of Staff, Director for Strategic Plans and Policy, **Joint Vision 2020** (Washington, D.C.: U.S. Government Printing Office, June 2000), pp. 8, 22, 24. Hereinafter **Joint Vision 2020**.

[15] **QDR**, op. cit., p. 30.

The QDR acknowledges that, "The increasing dependence of societies and military forces on advanced information networks creates new vulnerabilities and opportunities. Potential adversaries could exploit these vulnerabilities through means such as computer network attack and directed energy weapons."[16]

EMP attack could also exploit the U.S. military's increasing dependence on advanced information systems and other sophisticated electronics. The potential vulnerability to EMP of the "transformed" U.S. military of the future was demonstrated, inadvertently, in an advanced war fighting experiment conducted by the U.S. Army in March 1997 at the National Training Center in the California desert. In the military experiment, the U.S. Army tested a futuristic Force XXI armored brigade, the Army's first "digitized" brigade known as "EXFOR," in mock combat against a conventionally equipped brigade. The outcome was a stalemate, due to problems with the "digitized" brigade's electronic systems. Although the scenario did not include an EMP attack, the electronic problems that occurred are the kind that could be induced by EMP:

> *Computers crashed, desert dust played havoc with the computer fans and trackballs, information overload was a real problem not only for the junior officers trying to make quick decisions but also for the vehicle appliques which locked up and had to be rebooted. The sky was so full of electronic communications that conventional radio messages could not get through. Red vehicle icons on the applique screens were not updated quickly enough and they became "stale" and untrustworthy….The EXFOR force lost an unusually high number of friendly fire casualties, about 30 incidents of fratricides, compared to 30 for all three previous brigades which rotated through the NTC. (Sean J. A. Edwards, "The Threat of High Altitude Electromagnetic Pulse to Force XXI," National Security Studies Quarterly, Autumn 1997.)*[17]

Present and future adversaries may favor an EMP attack against the United States military because such an attack threatens satellites, communications, computers and those electronic systems that, now and in the future, are and will be most vital to U.S. military power. "Transformation" assumes that U.S. electronic superiority will enable ever smaller U.S. forces to outfight larger adversary forces. For example, a "digitized" U.S. brigade is expected to defeat an enemy division or corps. If an EMP attack cancels the United States electronic advantage, quantity may matter more than quality on the battlefield.

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16 Ibid, p. 31.

17 Sean J. A. Edwards, "The Threat of High-Altitude Electromagnetic Pulse to Force XXI," **National Security Studies Quarterly** (Autumn 1997), p. 77 fn 27. Hereinafter **NSSQ**.

Why EMP?

Given that the United States faces a host of actual and emerging threats from biological, chemical, radiological, nuclear, and enhanced conventional (CBRNE) weapons of mass destruction, why should the U.S. be more concerned, or as concerned, about the EMP threat? The short answer is that potential adversary states, including those that support international terrorism, show a marked preference for ballistic missiles as their primary tool for deterrence, coercive diplomacy, or WMD war fighting, and EMP offers significant advantages over alternative attack options employing missiles or other means.

A capability for EMP attack offers numerous technical, operational, strategic and political advantages over other WMD options. EMP attack can compensate for technical and operational problems associated with missile reentry vehicle design, fusing, accuracy, range, intelligence on target location, collateral damage, and missile defense penetration. Strategically and politically, a capability for EMP attack is among the most credible WMD threats for deterrence or blackmail because it would attack electronics, not people. In contrast to the limited effect radius of other WMD options, EMP can threaten entire regional or national infrastructures that are vital to U.S. military strength and societal survival, or challenge the integrity of entire allied coalitions. EMP attack would likely pose a retaliatory dilemma for the United States, since EMP is an asymmetrical threat, more dangerous to the electronically advanced West than to underdeveloped Third World rogue states. EMP is also a force multiplier that, if used in conjunction with other WMD options, would probably greatly increase their effectiveness.

Because EMP is of necessity a missile threat, weighing the relative importance of EMP attack, compared to other possible CBRNE threats, reduces to two issues. First, why would potential adversaries prefer missiles over clandestine delivery by ships, trucks, cruise missiles or other means of delivering, or threatening to deliver, weapons of mass destruction? Second, why would potential adversaries prefer an EMP attack over other missile attack options?

The Greatest Threat: Ballistic Missiles

On the first issue—the relative importance of missiles compared to other delivery means for WMD—the intelligence community judges, in the unclassified summary of the NIE **Foreign Missile Developments and the Ballistic Missile Threat Through 201**5 (December 2001), "The probability that a missile with a weapon of mass destruction will be used against U.S. forces or interests is higher today than during most of the Cold War." Further, the intelligence community implicitly acknowledges in the NIE that ballistic missiles are a greater threat, as opposed to a more likely threat, compared to clandestine delivery of WMD by ships, trucks, airplanes, cruise missiles or other means because, "Nonmissile means of delivering weapons of mass destruction do not provide the same prestige or degree of deterrence and coercive diplomacy."[18]

[18] NIE (December 2001), op. cit., pp. 7, 15.

Ballistic missiles are primarily national policy tools of deterrence and coercion. States acquire ballistic missiles for a variety of reasons: for prestige, to deter foreign powers, or to blackmail other states. As tools of national policy, long-range missiles are not expected to be used as war fighting instruments in the normal course of events. Rather, the threat inherent in the mere existence of an ICBM or MRBM capability is intended as a powerful, but silent, fact that must be taken into account by other states both in their daily and long-term decisions, influencing positively the international environment on a broad range of issues, in addition to national security.[19]

Thus, ballistic missiles, compared to other means of delivering WMD, do in fact constitute the greater threat to the United States. Clandestine delivery of WMD by ships, trucks, or airplanes could kill thousands of Americans. But non-use of ballistic missiles, their mere threatened use, could conceivably deter the United States, or tempt rogue states to reckless aggression, destabilize the world order, and ultimately kill even more Americans, without a single missile being fired.[20] And if ballistic missiles are fired, as shall be shown, they are likely to be more efficient at killing Americans than any other WMD delivery means.

According to the unclassified National Intelligence Estimate Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015 of September 1999:

> *Over the last decade, the world has observed that missiles less capable than the ICBMs the United States and others have deployed can affect another nation's decision-making process. Though U.S. potential adversaries recognize American military superiority, they are likely to assess that their growing missile capabilities would enable them to increase the cost of U.S. victory and potentially deter Washington from pursuing certain objectives.*[21]

History and current events demonstrate that the United States has not been deterred or blackmailed successfully by rogue states or terrorist groups capable of delivering a clandestine WMD attack against U.S. forces or the United States' homeland. Libya, for example, pursued an aggressive campaign of terrorism against the United States in the 1970s and 1980s, and was capable of mounting chemical or biological WMD attacks. But Tripoli was unable to blackmail the U.S. into changing its pro-Israel foreign policy, or even to deter the U.S. from attacking Libya. Nor has the United States been deterred from destroying the Taliban and Al Quaeda, despite their demonstrated capability to make clandestine WMD attacks against the U.S. homeland.

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19 David R. Tanks, **National Missile Defense: Policy Issues and Technological Capabilities** (Washington, D.C.: Institute for Foreign Policy Analysis, July 2000), pp. 1.3-1.5.

20 National Intelligence Council, **Global Trends 2015: A Dialogue About the Future With Nongovernment Experts**, NIC 2000-2 (Central Intelligence Agency: December 2000), p. 58.

21 National Intelligence Council, **Foreign Missile Developments and the Ballistic Missile Threat Through 2015** (Central Intelligence Agency: National Intelligence Estimate, September 1999), p. 7. Hereinafter NIE (September 1999).

In contrast, nations that have acquired ballistic missiles and WMD, and so have a highly visible force-in-being that can pose a clear and present danger to U.S. forces or to the United States itself, tend to be treated with much greater caution, and even with greater respect, than nations that lack WMD missiles, despite their capability to threaten WMD terrorism. Entry into the "nuclear missile club" has long been an international hallmark of becoming a "great power," or at least a "special power" in a more elevated category than other nations. North Korea has long had the largest contingent of special forces in the world with substantial capabilities for WMD clandestine operations. Yet it was not until North Korea acquired WMD missiles that the United States, under the Clinton Administration, began making diplomatic and economic concessions in an effort to "normalize" relations with Pyongyang.[22] Iran and Iraq, by virtue of being WMD missile states, are the focus of a great debate over whether or not the current war on terrorism should be carried to them, in stark contrast to the fate of Afghanistan's Taliban, who had no WMD missiles to prompt such controversy.

Delivery of WMD by trucks, ships, or airplanes might be "more likely" to occur than missile attacks—although even this is not clear—but the "most likely" threat is rarely "the greatest" or the "most important." During the Cold War, a nuclear conflict was judged the least likely threat, but its deterrence was accorded the highest priority in U.S. defense and foreign policy because the consequences of a nuclear war, or of nuclear blackmail, would be so grave. Ballistic missiles, and EMP attack in particular, are now at or near the pinnacle of the threat spectrum—without necessarily being less likely than other WMD threats of lesser gravity.

Missiles versus Clandestine Delivery Means

The 2001 NIE judges that missiles, including cruise missiles, are less likely to be employed against the United States than, "Ships, trucks, airplanes, and other means" of clandestine delivery.[23] This judgment seems intuitively obvious in that ships, trucks, and airplanes, it is generally assumed, are more likely to be available to potential adversaries than cruise or ballistic missiles and the nuclear weapons needed for an EMP attack. But missiles are becoming commonplace, as may in the future nuclear or non-nuclear weapons capable of making an EMP attack.[24]

However, the 2001 NIE's judgment that potential adversaries are more likely to employ "nonmissile means" instead of missiles for delivery of WMD is based, not on the argument of availability, but on several premises of more doubtful merit.

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22 Benjamin A. Gilman, Chairman, **North Korea Advisory Group Report to the Speaker U.S. House of Representatives** (Washington, D.C.: U.S. Government Printing Office, November 1999), pp. v-vi. Hereinafter **North Korea Advisory Group**.

23 NIE (December 2001), op. cit., p. 15.

24 During the Cold War, the intelligence community, in a now declassified Top Secret National Intelligence Estimate, arrived at an opposite conclusion from the 2001 NIE, judging that ballistic missile delivery of WMD was far more likely than delivery by ship, truck or other clandestine means. The Soviet-era NIE's arguments against clandestine delivery of WMD are largely still valid for today's potential state and terrorist adversaries. See: National Intelligence Estimate, **The Clandestine Introduction of Weapons of Mass Destruction Into the U.S.** (Central Intelligence Agency, 13 March 1963).

The 2001 NIE claims that "nonmissile means…are less expensive than developing and producing ICBMs."[25] But the cost of clandestine delivery is not merely the price of an aircraft, ship, or truck, and the weapon of mass destruction. The real cost of clandestine delivery includes the terrorist or special forces organization, the cost of its recruitment, training, and maintenance over many years.[26] For example, according to the Defense Intelligence Agency's North Korea: The Foundations for Military Strength (1995), North Korea maintains a large, highly-trained special operations force of 100,000 for clandestinely penetrating and conducting operations in the enemy's rear area.[27] Yet, despite having this impressive, and undoubtedly expensive, capability for clandestine delivery of WMD, North Korea is the leader among rogue states in developing ballistic missiles. Further, the political costs and military risks of sponsoring a semi-autonomous terrorist organization, that could entail international economic sanctions and perhaps involve the state in unwanted military conflicts, are likely to be considerable.

The 2001 NIE assumes that delivery of WMD by ship, truck, or other clandestine means could enable an aggressor to attack without revealing his identity and "escape retaliation."[28] However, during a crisis or war, when WMD use is most likely to occur, a CBRNE attack against the United States clandestinely delivered will do little to conceal the identity of the aggressor. As for a clandestine attack delivered during peacetime, the United States has a good record of identifying the perpetrators of such acts. Al Quaeda's clandestinely delivered attack on September 11 on New York and Washington has not enabled the terrorists or Afghanistan's former rulers to escape retribution. In the past, the United States has often known which states and terrorist organizations were responsible for a clandestinely delivered attack on U.S. forces, overseas civilians, or allies, but has been reluctant to act in part because the state sponsors often possess WMD armed missiles.

The 2001 NIE contends that clandestine delivery of WMD, "Probably would be more reliable than ICBMs that have not completed rigorous testing…Probably would be much more accurate than emerging ICBMs…Probably would be more effective for disseminating biological warfare agent than a ballistic missile."[29] All of this assumes that a potential adversary would have high confidence that his terrorists or special forces could penetrate U.S. security and accomplish their missions. The technical risks associated with a little tested ICBM most likely pale in comparison to the operational risks associated with a terrorist or special forces attack, especially when conducted against the U.S. military during a crisis or war, when the United States will be most alert to such a threat.

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25 NIE (December 2001), op. cit., p. 15.

26 Iran, for example, is estimated to spend $100 million annually supporting terrorists, more than it spends on long-range ballistic missiles. "U.S. Officials Say Iran is Funding Terrorists," **St. Louis Post-Dispatch** (14 May 1995), p. 3A. "Missile Exports Earn Pyongyang $770 Million A Year, Report Says," **South China Morning Post** (3 April 1999).

27 Defense Intelligence Agency, North Korea: The Foundations of Military Strength (1995). North Korea Advisory Group, op. cit., p. 25.

28 NIE (December 2001), op. cit., p. 15.

29 Ibid.

The wartime record of strategic clandestine operations is not good, especially when compared to the wartime accomplishments of missile attacks. For example, during World War II, Nazi Germany's ambitious sabotage campaign against British industry accomplished little, compared to the V-1 and V-2 missile attacks.[30] The Iran-Iraq war was decided by the missile "war of the cities," whereas the heavy investment in terrorists on both sides—Iran is the world's leading sponsor of terrorism—returned little or nothing of military value.[31] Iraqi missiles were strategically and psychologically very significant during the Persian Gulf war, threatening to break the allied coalition through missile attacks on Israel, eluding U.S. attempts to destroy the mobile launchers, and killing more Americans than any other weapon used by Iraq.[32] Iraqi special forces and state-sponsored terrorists contributed little noteworthy to the Iraqi war effort. After the war, Iraq's clandestine operation to assassinate President Bush failed.[33] Rogue state missiles have tended to work, often better than expected. Rogue state clandestine operations have tended to fail.

The 2001 NIE observes that ships, trucks and other clandestine means of delivering WMD "would avoid missile defenses."[34] This is true. But terrorists and special forces must avoid the FBI, CIA, NSA, Mossad and the vast panoply of other counterterrorism, intelligence, and police forces wielded by the United States and its allies. The actual effectiveness of these agencies in preventing clandestine attacks may be less important than their perceived effectiveness by adversaries. Rogue states have excellent internal security, are likely to mirror-image and overestimate the internal security of the U.S., and calculate the risks of clandestine WMD delivery accordingly.

In fact, clandestine delivery of WMD would be risky. Even during peacetime, against an unprepared United States, the Al Quaeda terrorists of September 11 did not succeed in all their missions. Some were defeated by modest U.S. security precautions, and some by heroic civilians. To be militarily useful, clandestine delivery may have to penetrate secure U.S. military facilities, which may be a harder task than penetrating U.S. missile defenses.

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30 Ladislas Farago, The Game of the Foxes: The Untold Story of German Espionage in the United States and Great Britain during World War II (New York: D. McKay Co., 1972). William Breuer, Hitler's Undercover War: The Nazi Espionage Invasion of the U.S.A. (New York: St. Martin's Press, 1989). Guido De Maeseneer, Peenemunde: The Extraordinary Story of Hitler's Secret Weapons V-1 and V-2 (Vancouver, Canada: AJ Publishing, 2001). Walter Dornberger, V2 (London: Hurst and Blackett, 1954).

31 "More than 1,000 surface-to-aurface missiles of all ranges were fired during the War of the Cities in the Iran-Iraq war….160 of which were aimed at Tehran; the missiles caused approximately 2,000 Iranian casualties, evacuation of half the population of Tehran, and a severe disruption in the Iranian war economy. To many observers in the developing world, the war showed the decisive quality of the modern ballistic missile." From Thomas G. Mahnken, "The Arrow and the Shield: U.S. Responses to Ballistic Missile Proliferation," **The Washington Quarterly** (Center for Strategic and International Studies and the Massachusetts Institute of Technology, Winter 1991). See also: John Arquilla, "A Missile Defense 'Third Way'," **Christian Science Monitor** (22 August 2000).

32 Jackson Diehl, "Israel's Moment of Truth: Restraint or Retaliation?," **Washington Post** (19 March 1991). Nick B. Williams Jr., "Syria Stalls Iraqi Bid to Widen War," **Los Angeles Times** (25 January 1991). Peter Riddell and Lionel Barber, "U.S. Seeks to Restrain Israel: Allies Told to Increase Raids on Scud Sites," **Financial Times** (19 January 1991).

33 Bill Turque et al., "Striking Saddam," **Newsweek** (5 July 1993), p. 16. Douglas Jehl, "Raid on Baghdad: U.S. Says It Waited For Certain Proof Before Iraq Raid," **New York Times** (29 June 1993). Martin Fletcher and Ben Macintyre, "UN Accepts Clinton Evidence That Iraq Plotted to Kill Bush," **The Times** (29 June 1993).

34 NIE (December 2001), op. cit., p. 15.

Finally, for optimum strategic and military effect, a WMD attack on the United States would likely aim at more than one target and try for coordination with other operations happening in the U.S. and elsewhere in the world. A single clandestine WMD attack delivered prematurely could jeopardize all the others, and delivered late could lose the war. Ballistic missiles can much more assuredly accomplish attacks requiring coordination and precise timing against multiple targets than ships, trucks or other clandestine delivery means.

Ballistic versus Cruise Missiles

Would a potential adversary prefer cruise missiles over ballistic missiles for delivery of WMD against the United States? The 2001 NIE notes that cruise missiles have many technical and operational shortcomings for this purpose:

> *Technically, cruise missiles can be launched from fighter, bomber, or even commercial transport aircraft outside U.S. airspace. Both the perceived U.S. capability to detect and track threats approaching the coast, and the limited range of most foreign fighter and bomber aircraft, however, tend to mitigate such a threat. Modifying a commercial aircraft to become a cruise missile platform would entail significant aerodynamic, structural, electrical, and possibly flight control system modifications. Cruise missile launches from a submarine would have the advantage of being relatively covert. The technical sophistication required to design or modify a cruise missile for launch from a torpedo or missile tubes, however, almost certainly would require detailed assistance from the defense industry of a major naval power.*[35]

ICBMs, compared to cruise missiles, aircraft and other possible delivery means for WMD against the United States, are the only system against which there is currently no defense. U.S. capabilities to defend against advanced cruise missiles are minimal, but at least the United States does have a rudimentary air defense. When U.S. air defenses are alerted during a war or crisis, they could be a significant barrier to primitive cruise missiles. U.S. air defenses can more rapidly be upgraded against advanced cruise missiles than the development and deployment of ballistic missile defenses that at present do not exist.

Further, unlike cruise missiles, ballistic missiles can be launched from the territory of the hostile country. Cruise missiles, ships, trucks and other means of delivering WMD require the movement of people and equipment near or in the United States, thus providing an opportunity for interdiction. Compared to other delivery means discussed here, only the ballistic missile can be launched from the territory of a hostile state against the United States, with no current means of defense, except for the threat of U.S. retaliation or preemptive attack.[36]

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[35] Ibid, pp. 14-15.

[36] Tanks, op. cit., pp. 1.2-1.3. David Tanks, **Assessing the Cruise Missile Puzzle: How Great A Defense Challenge?** (Washington, D.C.: Institute for Foreign Policy Analysis, 2000), p. 23. Congressional Research Service, **Cruise Missile Proliferation**, RS21252 (3 July 2002), p. 6.

EMP Attack: Technical and Operational Advantages

Why would an adversary armed with ballistic missiles and nuclear weapons prefer EMP attack over other missile attack options?

The 2001 NIE projects that over the next 15 years, rogue state missiles are likely to be inaccurate, infrequently flight-tested, and suffer from a number of other technical limitations.[37] This is the basis for the analysis below that EMP attack offers technical and operational advantages over other missile attack options because EMP can compensate for: poor reentry vehicle technology, poor fusing technology, missile inaccuracy, and limitations in missile range.

However, these technical and operational advantages offered by EMP attack may be transitory if proliferation of technology proceeds faster and deeper than anticipated by the NIE, as some analysts believe is likely. Nonetheless, other technical and operational advantages offered by EMP attack that are also discussed below—EMP attack as a means of coping with poor intelligence and moving targets, as a means of limiting collateral damage, and as a means of coping with missile defenses—are less sensitive or are insensitive to the proliferation of technology, and are likely to endure.

The bottom line is that EMP attack offers numerous technical and operational advantages over using ballistic missiles for nuclear blast, biological, chemical, or enhanced conventional attack.

An EMP attack does not face the added challenge of atmospheric reentry, as do other attack options. During atmospheric reentry, the missile warhead will be exposed to intense heat, reaching hundreds of degrees Fahrenheit, and to g-forces that would stress the weapons package and internal mechanisms of the warhead. These are daunting engineering challenges when there is little or no opportunity to flight-test missiles and warheads, as is expected to remain the case for rogue states in the future.

A nuclear weapon delivered for EMP would be detonated at least 30 kilometers above the Earth's surface, and perhaps at an altitude of hundreds of kilometers, depending upon the desired coverage, field strengths, and other targeting requirements for the EMP attack. Thus, the EMP attack occurs above the atmosphere, eliminating the need for atmospheric reentry

In contrast, other attack options would require the warhead to penetrate the atmosphere, in most cases to within less than one kilometer from the Earth's surface. An attack relying on nuclear blast, biological, chemical, or enhanced conventional weapons—such as fuel-air explosive bombs or submunition bomblets—would require virtually complete atmospheric penetration. Rogue state warheads, expected to be delivered inaccurately by missiles having primitive guidance systems, could be rendered even more inaccurate by winds and uneven ablation of the heat shield, making the attack miss target. Lightening, storms, hail and other meteorological conditions could damage or destroy a poorly designed warhead.

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[37] NIE (December 2001), op. cit., pp. 4, 6, 7, 14, 15. NIE (September 1999), op. cit., pp. 4, 6, 7, 8.

Biological agents are particularly vulnerable to heat, that can kill pathogens or neutralize organic toxins. A missile delivering biological agents would probably require a warhead designed to cool the BW package during reentry. The heat of atmospheric reentry can also neutralize nuclear, chemical, and enhanced conventional weapons, if they are not adequately shielded.

Uncertainties associated with the survival and performance of the warhead would, for states having limited missile flight-test experience, probably decrease their confidence in attack options requiring atmospheric reentry.

An EMP attack does not face the challenge of atmospheric detonation at a precise altitude, or of ground detonation. Fusing mechanisms for an EMP burst could tolerate inaccuracies of many kilometers, without foiling or appreciably degrading the effectiveness of an EMP attack.

All missile attack options requiring atmospheric reentry also require robust and accurate fusing mechanisms to detonate the weapon at the desired altitude. For example, in order to maximize nuclear blast against buildings, the optimum burst-height for a 20-kiloton nuclear weapon, the nominal yield expected for a rogue state warhead of first generation design, is about 3 kilometers.[38] Optimizing a nuclear attack for a combination of nuclear blast, ground shock, and radioactive fallout effects would require a contact surface burst, or better yet, slight earth penetration. These are significant engineering challenges, as the warhead must be designed to preserve the nuclear physics package from the shock of ground impact. A poorly designed warhead attempting a surface or sub-surface burst might not adequately protect the physics package, and fail to produce a nuclear explosion.

Biological, chemical, and enhanced conventional weapons, such as fuel-air explosive bombs or submunition bomblets, require more accurate fusing than nuclear weapons. Ideally, these weapons should be delivered to within much less than one-kilometer of the Earth's surface before activation, to a precise burst height. If the burst height for biological, chemical, or enhanced conventional weapons is too high, the effectiveness of the attack on target may be greatly reduced. Even if a large city is targeted, winds could so disperse biological or chemical agents, or carry them so far off target, as to render them harmless. The effective radius of most enhanced conventional weapons is less than a few hundred meters, and so cannot compensate for much inaccuracy in fusing.

If the fusing mechanism fails and nuclear, biological, chemical or enhanced conventional weapons impact the ground unintentionally, they would most likely be neutralized. Uncertainties associated with the performance of fusing mechanisms, for states having limited test experience, might be another factor decreasing their confidence in missile attack options requiring delivery of weapons within the atmosphere.

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[38] Overpressure of 5 psi will destroy ordinary brick and frame structures. Samuel Glasstone and Philip J. Dolan (eds.), **The Effects of Nuclear Weapons** (Washington, D.C.: U.S. Department of Defense and U.S. Energy Research and Development Administration, 1977), pp. 178-184.

EMP attack does not require precise intelligence on target location, and would better cope with moving targets than other missile attack options. The radius of EMP effects on the ground would be hundreds or even thousands of kilometers. Uncertainty about precise target coordinates, and moving targets such as aircraft, ships, and ground forces, would not be a significant impediment to the successful execution of an EMP attack.[39]

In contrast, because the effective radius of nuclear blast, biological, chemical, and enhanced conventional attack is several kilometers or less, precise intelligence on target location is required for a successful attack by these means. Rogue states may lack adequate geodetic and other data to support sufficiently accurate delivery of a weapon against even fixed targets, let alone mobile targets. Real time intelligence would be required in order to support an attack against a mobile target. An aircraft carrier, for example, could move more than 40 miles off of a missile aimpoint based on relatively "fresh" intelligence only one-hour old. It is doubtful that rogue states would have the software and other capabilities necessary to support rapid retargeting of missiles, especially against moving targets at long ranges.

Rogue state missiles are expected to have primitive guidance systems, making them inherently inaccurate.[40] Additional inaccuracies because of inadequate intelligence on target location would further decrease the effectiveness of missile attack options relying on nuclear blast, biological, chemical, or enhanced conventional weapons.

EMP attack, especially for inaccurate rogue state ICBMs operating at intercontinental ranges, is likely to be more effective than other missile attack options against military targets. The wide radius of an EMP field, extending tens of kilometers for peak field strength and hundreds or perhaps thousands of kilometers in radius for the entire field, makes an EMP attack largely insensitive to missile accuracy. In contrast, missile attack options employing nuclear blast, biological, chemical, or enhanced conventional weapons, that have lethal radii equivalent to several kilometers or less, would be ineffective against military targets if missile accuracy is poor.

According to the U.S. Air Force's National Air Intelligence Center, in **Ballistic and Cruise Missile Threat** (April 1999), "A high quality inertial guidance system is capable of placing a reentry vehicle within a few hundred feet of the target after a flight of over 6,000 miles." However, rogue state missiles, employing primitive guidance systems, are highly inaccurate. The NAIC study notes, "Many of the missiles in use today, particularly among Third World nations, use relatively unsophisticated guidance systems that are only capable of delivering a reentry vehicle (or missile with a non-separating warhead) within a half mile to a mile of a target after a flight of only a few hundred miles."[41] Such missile inaccuracy against an intercontinental target,

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[39] U.S. House of Representatives, Committee on Armed Services, **Electromagnetic Pulse Threats To U.S. Military and Civilian Infrastructure**, Hearing before the Military Research and Development Subcommittee, 7 October 1999 (Washington, D.C.: U.S. Government Printing Office, 2000), p. 68. Hereinafter HASC Hearing (7 October 1999).

[40] NIE (September 1999), op. cit., p. 4.

[41] National Air Intelligence Center, **Ballistic and Cruise Missile Threat**, NAIC-1031-0985-99 (Wtight-Patterson AFB, Ohio: April 1999), p. 3.

some 6,000 miles away, would translate into a miss distance of about 10-20 miles (15-30 kilometers).

Such missile inaccuracy would have little or no consequence for the effectiveness of an EMP attack. A missile having a CEP (Circular Error Probable—the radius of a circle within which a missile could deliver a warhead half the time) of 30 kilometers could place its warhead somewhere within a circular area covering about 2,800 square kilometers. This uncertainty created by missile inaccuracy would be canceled by an EMP attack with its wide area of effect, covering potentially millions of square kilometers.

Although an attacker might have great uncertainty about the specific damage an EMP attack would inflict, he at least could be confident that the EMP attack would not miss target.

In contrast, an ICBM attack employing nuclear blast, biological, chemical, or enhanced conventional weapons against a U.S. military target, given a missile CEP of 15-30 kilometers, would most likely prove ineffective. A high-value military target in the United States that a rogue state might consider worth attacking with an ICBM is Whiteman AFB, in particular the runways supporting B-2 operations, that cover an area of about 10 square kilometers. This is one of the largest, easiest to hit, high-value military targets in the United States. Postulate that a North Korean ICBM having a CEP of 15-30 kilometers could deliver a 20-kiloton nuclear warhead, a biological warhead containing anthrax, a chemical warhead containing sarin nerve gas, or an enhanced conventional warhead with anti-runway submunitions. The odds that any of these warheads would be delivered close enough to Whiteman AFB to place a lethal radius on the runways is less than 1-3 percent.[42]

Even as non-military terror weapons for attacking cities at intercontinental ranges, nuclear blast, biological, and chemical weapons would be of problematical lethality, if delivered by an ICBM having the very poor accuracy expected for rogue state missiles. The U.S. Congress' Office of Technology Assessment (OTA) produced a study, **Proliferation of Weapons of Mass Destruction: Assessing the Risks** (August 1993), that calculated the lethality of a generic rogue state missile delivering a nuclear, biological, or chemical warhead against the population of Washington, D.C.. The study postulated a missile having a payload of 1,000 kilograms, *but took no account of missile accuracy*. In effect, the OTA study assumed perfect missile accuracy that

[42] Lethality is calculated as the ratio of the lethal area of the weapon against the area of uncertainty about where the weapon might impact, as derived from the missile's circular area probable (CEP—the radius of a circle wherein the warhead has a 50 percent probability of impacting). For example, a 20 kiloton warhead having a CEP of 15 kilometers has a 50 percent chance of striking anywhere within a radius of 15 kilometers around aimpoint, an area of about 700 square kilometers. If the lethal radius of the warhead is 3 kilometers (about the range for 5 psi overpressure from a 20 kiloton warhead), then lethal area is about 28 square kilometers, or merely 4 percent of the 700 square kilometer area of uncertainty around the aimpoint where the warhead might impact. Since the odds of placing the warhead within the CEP of 15 kilometers is 50 percent, the odds that the warhead will place its lethal area on target is the ratio of the warhead's lethal area against the area enclosed by the warhead's CEP, halved, or about 2 percent. The same calculations apply to biological and chemical weapons.

allowed delivery of its weapon against the densely populated District of Columbia (inhabited by 3,000-10,000 people per square kilometer).[43]

According to the OTA study, an accurate missile delivering a Hiroshima-size nuclear weapon (12.5 kilotons yield) against Washington, D.C., and detonated at optimum burst height for blast and prompt radiation, would kill 23,000-80,000 people. In the OTA study, an accurate missile delivering a biological weapon—30 kilograms of anthrax spores—dispersed in a trail 10 kilometers long and 1 kilometer wide over Washington, would have a lethal area of 10 square kilometers, and kill 30,000-100,000 people. The OTA study also postulates an accurate missile delivering a chemical weapon—300 kilograms of sarin nerve gas—would have a lethal area of 0.22 square kilometers, and kill 60-200 people.[44]

However, if the OTA missile attacks on Washington postulated above take into account the poor accuracy estimated for rogue state ICBMs, their effectiveness is more dubious. If the CEP of the attacking missile is 15 kilometers, the odds are better than 40 percent that its weapon will be delivered outside the District of Columbia, in the much less densely populated suburbs or countryside. If the CEP of the missile is 30 kilometers, the probability that its warhead will miss Washington is 85 percent.

An adversary seeking to kill and injure people could compensate for poor missile accuracy and maximize casualties by ground bursting a nuclear warhead to create radioactive fallout. Fallout will contaminate an area of hundreds or thousands of square kilometers, and would almost certainly produce thousands of casualties, even if the missile is grossly inaccurate.[45] Even so, the attacker would have little control over the fallout pattern, and probably could not with high confidence target a particular city, like Washington, for military or symbolic purposes. Moreover, a nuclear missile attack for fallout would still face the challenges of penetrating missile defenses, atmospheric reentry, and fusing. No fallout will be created if the warhead is intercepted by missile defenses, burns up in the atmosphere, or is destroyed on impact because of poor fusing. These challenges are less relevant (in the case of missile defenses) or are irrelevant (in the cases of atmospheric reentry and fusing) in an EMP attack.

EMP attack would enable missiles to attack targets that ordinarily, using any other attack option, are beyond their range. A nuclear burst at high-altitude will propagate an EMP field from the point of explosion to the line of sight on the Earth's horizon, a radius for EMP effects extending potentially thousands of kilometers, depending on the burst height. The higher an EMP burst occurs, the further and wider the "horizon" of effect. For example, a nuclear weapon burst at an altitude of 100 kilometers would project an EMP field on the Earth's surface having a

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43 Office of Technology Assessment, **Proliferation of Weapons of Mass Destruction: Assessing the Risks** (Washington, D.C.: August 1993), pp. 52-54.

44 Ibid, p. 53.

45 Natural Resources Defense Council, **The U.S. Nuclear War Plan: A Time For Change** (Washington, D.C.: 2001), pp. 32-34.

radius of roughly 1,000 kilometers. A nuclear burst at an altitude of 300 kilometers would project an EMP field having a radius of roughly 2500 kilometers.[46]

Because of the great radius of EMP effects, missiles used for this attack option could threaten targets far beyond their normal operational range. For example a North Korean No Dong MRBM, having an estimated range of 1,300 kilometers, could in effect extend its range to 2,300 kilometers or 3,800 kilometers or more in an EMP attack. Iran's Shahab III MRBM, that cannot quite reach Europe with its 1,300 kilometer range, could reach far into Europe, if used in an EMP attack. North Korea's Taepo Dong II, if deployed only in the two-stage and not the three-stage configuration, according to the 2001 NIE, "could deliver a several-hundred kilogram payload up to 10,000 kilometers—sufficient to strike Alaska, Hawaii, and parts of the continental United States." If used in an EMP attack, the two-stage Taepo Dong II could threaten most of the continental United States.[47]

Thus, EMP attack offers potential adversaries a means to, in effect, convert short-range ballistic missiles into medium-range missiles, convert MRBMs into IRBMs, and convert IRBMs into ICBMs.

EMP attack would likely pose less collateral risk to the aggressor in a theater of operations compared to other missile attack options. Because the attacker knows precisely when he will execute an EMP attack, he can target the attack in such manner and prepare his own forces in ways to minimize damage to his own troops and operations. Except for the damage to electrical systems and dependent infrastructure, EMP attack leaves no persistent after effects. The same cannot be said of nuclear blast, biological, and chemical weapons.

For example, if North Korea uses weapons of mass destruction against the U.S. and South Korean forces near the demilitarized zone, the North could seriously impede its own military operations attempting to overrun the South. Nuclear blast would likely block roads, destroy bridges and railways. "Hot zones" of radiation, biological and chemical contaminants could also hamstring North Korean offensive operations into the South. Radiation, biological and chemical agents will contaminate the area for years, reducing the value of conquered territory. Wind and weather could possibly return contamination to the aggressor's homeland. Although an EMP attack might effect some of the aggressor's forward troops, despite their foreknowledge and preparation, at least EMP will not create persistent roadblocks that impede the aggressor's advance.

For a further example, suppose China uses nuclear weapons in an attempt to blast its way through the air defenses of an aircraft carrier group, in order to open a corridor for air and naval strikes on the carrier. Chinese strike forces would have to operate within the nuclear targeted area in order exploit opportunities created by the nuclear strikes. Nuclear strikes on Aegis cruisers and other picket ships would pose a significant risk of collateral damage to Chinese

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[46] The higher a HEMP burst, the longer its radius of effect, extending to the earth's horizon. An equation for calculating how HEMP radius increases with altitude is given in **NSSQ**, op. cit., p. 78 fn 35.

[47] For estimated ranges of missiles see: NAIC, op. cit., p. 9.

strike forces and would likely impede operations through obscuring targets visually and electronically. In contrast, an EMP attack could be timed and located to spare Chinese forces from collateral damage, and would create no atmospheric perturbations that could interfere with targeting and strike operations.

EMP attack would be less vulnerable to and more effective against missile defenses than other missile attack options. Since an EMP attack does not require atmospheric reentry, and can be executed in a way that allows a standoff distance from target of potentially thousands of kilometers, such an attack would be able to lessen the effectiveness of, or perhaps elude altogether, missile defenses. EMP also poses a significant threat to missile defenses, that are highly dependent upon radars, satellites, and other sophisticated electronic systems. The United States abandoned its Safeguard Anti-Ballistic Missile (ABM) system in the 1970s in part because of concerns that the system would be unable to cope with EMP effects.

In contrast, missile attack options relying on nuclear blast, biological, chemical, or enhanced conventional weapons will have to run the full gamut of U.S. theater or national missile defenses. An adversary might well provide its nuclear weapons with a salvage fusing option for EMP attack, just in case the warhead is intercepted above the atmosphere.

EMP Attack: Strategic and Political Advantages

EMP attack offers a number of strategic and political advantages over missile attack options employing nuclear blast, biological, chemical, or enhanced conventional weapons.

EMP promises a "bigger bang for the buck" by threatening simultaneously all military electronic systems in a broad region, potentially across an entire theater of operations. In comparison, the same single missile employed for an EMP attack, if otherwise used for nuclear blast, biological, chemical, or enhanced conventional missile attack, would destroy only a single target. An adversary would probably attach much greater strategic value to an EMP attack that achieves overall degradation and disruption of U.S. military forces on the battlefield and beyond than to a CBRNE attack that destroys a single airfield, but leaves overall U.S. war fighting capabilities undegraded.

EMP threatens the most valuable U.S. military targets—satellites; command, control, and communications; and high-tech weaponry dependent upon sophisticated electronics. Official unclassified U.S. military doctrine acknowledges that sensors and information systems are now more important to U.S. military strength than weapons and delivery systems.[48] Destroying a U.S. military base and killing U.S. troops with nuclear blast, biological or chemical agents, or enhanced conventional weapons, might be likened to a body blow in a boxing contest—a blow that can be returned manifold and much harder by the United States, as long as its electronic central nervous system remains intact. An EMP attack constitutes a blow against the United States military's central nervous system.

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[48] **Joint Vision 2020**, op. cit., p. 3. **QDR**, op. cit., p. 30.

EMP also promises a "bigger bang for the buck" in an attack that tries to inflict as much damage as possible on the United States' society. Nuclear blast, biological, or chemical attack might damage or destroy a U.S. city and promptly kill hundreds or thousands of Americans. However, except in the case of a massive attack by Russia on U.S. cities, the damage to the United States' economy and the loss of life would probably be recoverable. EMP is probably the most damaging use of a single or small number of missiles.

EMP attack threatens the civilian electronic infrastructure—power, telecommunications, transportation, computers and information systems—that is the foundation of the United States' economy, political system, and social order. An EMP attack would probably cause more material damage, more costly damage, and affect more Americans than any other attack option executable with one or a few missiles.[49] If damage to the U.S. civilian infrastructure is sufficiently widespread, it may not be recoverable. Under these circumstances, compared to other attack options, an EMP attack could conceivably kill more Americans in the long run.

EMP is an asymmetrical threat more dangerous to the United States' military forces and society than to most potential adversaries, especially rogue states and terrorists. North Korea, Iran, Iraq, China, and most other potential adversaries of the United States are not nearly as dependent as is the United States upon a sophisticated electronic military and civilian infrastructure. The threat or fact of an EMP attack upon U.S. forces or society would confront the United States with a retaliatory dilemma.[50] Perhaps worse, the asymmetrical risk inherent in an EMP threat may confer on U.S. adversaries a credible deterrent, as during the Cold War, but a deterrent that contains the United States, not the Soviet Union. U.S. military commitments to allies around the globe and U.S. willingness to act militarily has, up to now, been in an environment where rogue and non-state actors could not pose a lop-sided, vital threat to the U.S. homeland or to U.S. forces overseas. The credible capability to threaten the United States asymmetrically through EMP attack could change the whole calculus of risk and benefit for the United States that is the foundation of its current internationalist defense and foreign policy.

Because an EMP attack would target electronics, not lives, and probably cause relatively little prompt loss of life (compared to a nuclear or biological attack on a city), the United States may well be hard pressed to justify retaliating with weapons of mass destruction. An adversary might credibly argue to the international community that an EMP attack, delivered amidst a grave crisis or war, is a desperate act of "political signaling," a warning shot intended to prevent or de-escalate a conflict and return the parties to negotiation, lest WMD escalation ensues that causes "real" damage and loss of life.

The first use of nuclear weapons since Nagasaki is sure to be a potent political symbol, greatly elevating the visibility and international significance of any crisis or conflict. If an adversary uses a missile to blast or contaminate a U.S. city, it would instantly become a pariah and be abandoned by the international community to its fate at the hands of the United States.

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[49] HASC Hearing (7 October 1999), op. cit., p. 78.
[50] Ibid, pp. 79-81.

But if an adversary makes an EMP attack that "spares" American lives, especially if accompanied by a "peace offensive," there is some significant possibility that an international community anxious to avoid escalation might be recruited politically to the adversary's side.

Thus, EMP attack offers an adversary some prospect of being able to use nuclear missiles for maximum counterforce or countervalue effectiveness, while wrongly being credited by the international community as displaying restraint, and possibly escaping nuclear retaliation by the United States. EMP attack may be the nuclear war equivalent of "having your cake and eating it too."[51]

An EMP threat or actual attack, because of its broad area coverage, can be made simultaneously against all or most of the members of an allied coalition in a strategy of "divide and conquer." North Korea, for example, could use a single missile to make an EMP attack that would affect U.S. military forces in the theater, South Korea, and Japan—the allied principals in a crisis or conflict in the region. The cooperation of Seoul and Tokyo are indispensable to U.S. military operations on the Korean peninsula. Allied collective and individual political resolve, not just the political will of the United States, would be tested by an EMP attack. A coalition is only as strong as its weakest link.

EMP attack would probably greatly increase the effectiveness of all other WMD attack options, whether missiles, ships, trucks, airplanes or other means are used for delivery in the other attack options. For example, an attack employing biological or chemical weapons against one or several U.S. cities will be limited by the effectiveness of federal, state, and local agencies and emergency services in detecting and responding to that threat. If an EMP attack, by disrupting power and communications, slows the ability of the United States to detect and respond to a WMD biological or chemical attack, greater damage and more casualties will be produced. As the United States achieves greater preparedness against biological, chemical, and other WMD threats, an EMP attack that disrupts U.S. emergency preparations would be an increasingly valuable force multiplier for all WMD attack options.

Finally, no single or several dozen targets could be destroyed by nuclear blast, biological, chemical, or enhanced conventional weapons that could cripple decisively the United States military or society. *Only EMP attack can threaten the indispensable vitals of the United States society or military, and offer a rogue state some promise, however slim, of coercing from U.S. or allied governments, or achieving upon the battlefield, victory.*

[51] Ibid, p. 68.

EMP Scenarios

Many of the potential advantages of EMP attack are widely known to the general public. EMP scenarios have even been represented, with varying degrees of realism, in popular works of fiction and on television. Threat analyses by U.S. defense officials and academics have created scenarios for EMP attack spanning a broader range of military-political conditions than probably any other employment option for nuclear weapons. This implies something about the potential wide utility of EMP attack compared to other nuclear options, and may also imply something about its relative likelihood. The issue of likelihood aside, the broad range of plausible scenarios for EMP attack, and the particulars of those scenarios, is important to understand as a matter of defense preparedness.

An unclassified study by the U.S. Defense Threat Reduction Agency (DTRA), **NBC Scenarios: 2002-2010**, published in April 2000, postulates nine scenarios for attacks against the United States involving weapons of mass destruction, including a scenario for EMP attack. According to DTRA, "the scenarios provide credible and feasible possible future threats" in order to "challenge our thinking about future technologies, tools, doctrine, and policies and…stimulate new and innovative solutions."[52]

DTRA's NBC Scenarios hypothesizes the unauthorized launch of Russian strategic nuclear weapons against the United States in 2008 to perform an EMP attack:

> *In the postulated situation, a rogue Russian military cabal launches a single submarine-launched ballistic missile (SLBM) from a strategic ballistic missile submarine (SSBN), producing four nuclear detonations. These yield: (a) high altitude electromagnetic pulse (HEMP) effects that damage electronics and systems on the ground, and (b) high altitude nuclear effects on Low Earth Orbit systems (HALEOS) that damage satellites.*[53]

According to DTRA, "This scenario is designed to highlight the vulnerability of space-based assets and ground-based infrastructure to nuclear weapons."[54]

In the highly detailed scenario, a rogue Russian submarine commander threatens a nuclear attack unless key demands are met, that include:

- "Complete withdrawal of all NATO peacekeeping forces from the Balkans and all Western military presence from former East Bloc states;"
- "Cessation of NATO expansion, expulsion of members added since 1991, and a return to 'NATO borders' as they existed in December 1991;"

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[52] Defense Threat Reduction Agency, **NBC Scenarios: 2002-2010** (Washington, D.C.: DTRA Advanced Systems and Concepts Office and NDU Center for Counterproliferation Research, April 2000), p. vii.

[53] Ibid, p. 137.

[54] Ibid.

- "Formal public admission that NATO and other imperialist states have colluded to cause the economic and social disintegration of the Russian Federation;"
- "$100 billion in 'reparations' to be paid in compensation for the harm done to the Russian people; and"
- "Forgiveness of all outstanding foreign debt owed by Russia or the former Soviet Union."[55]

When the United States refuses to comply with these demands, the Russian submarine launches an EMP attack on the Hawaiian Islands that is "intended to serve as a clear warning to the United States, but at the same time to cause minimal casualties."[56] In the **NBC Scenarios**, four 100 kiloton warheads are detonated at pre-designated altitudes of 200 kilometers, 150 kilometers, and two at 75 kilometers, producing EMP fields that cover the Hawaiian Islands. According to DTRA:

> *Current surges induced by EMP can…increase the probability of upset and burnout occurring in electrical and electronic systems…EMP can cause this increase to occur nearly simultaneously over a large area, about one million square kilometers for a high-altitude burst…. EMP of 3 kilovolts per meter…is the nominal value for the onset of upset to unhardened consumer electronics…. EMP of 7 kilovolts per meter…is the area of damage (burnout).*[57]

According to DTRA's **NBC Scenarios**, an EMP attack over Hawaii would destroy and degrade satellites that are vital to the United States' national security and economy. More significantly, the EMP attack "could render the society largely inoperative for some time":

> *The immense footprint of EMP can simultaneously place at risk unhardened military systems, as well as critical* infrastructure systems that include power grids, telecommunications networks, transportation systems, banking systems, medical services, civil emergency systems and other systems. The overall effects on specific terrestrial systems are not well understood. It is difficult to predict how much of the telecommunications system would fail and for how long, how much of the power grid would be disrupted and for how long, and so forth. It is clear that he infrastructure, in general, has become more vulnerable to EMP because of the widespread use of…sensitive electronic components....[58]

DTRA's **NBC Scenarios** concludes, "In sum, the postulated EMP burst could result in the loss of nearly all communications systems, both military and civilian, that are located or transit the Hawaiian Islands. Additionally, the impact on the local civilian and military infrastructure

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55 Ibid, p. 142.
56 Ibid, p. 144.
57 Ibid, p. 147.
58 Ibid, p. 148.

due to the loss of a majority of essential systems and services could render the society largely inoperative for some time." Moreover, "Restoration of damaged or destroyed electronic devices and systems could take a significant amount of time, even in a limited area with a small population, such as Hawaii."[59]

DTRA's NBC Scenarios postulates another EMP attack scenario, again involving four 100-kiloton warheads, but this time launched against the continental United States. One warhead performs "a successful 100 kiloton burst at its desired altitude of 75 kilometers over the city of Boston…The burnout area covers the East coast from South Carolina to southeastern Canada." The second detonates "at an altitude of 75 kilometers over New York City. Again the effects cover a significant portion of the Eastern United States. Burnout may occur as far West as Chicago…and as far South as Charlotte, North Carolina." The third "warhead is intercepted by national missile defense assets, but because it is salvage-fuzed, it produces a 100 kiloton yield at 300 kilometers. The burnout area is reduced but still covers New York City…Philadelphia…and Washington, D.C.." The fourth and "final warhead is intercepted by national missile defense assets but salvage-fuzes to achieve a partial yield of 50 kilotons at an altitude of 250 kilometers. Due to the reduced yield the burnout area is significantly reduced, but it still covers the Washington, D.C. area."[60]

This second scenario for an EMP attack posited by DTRA results in electronic "burnout" of the eastern seaboard of the United States, about one-quarter of the nation's most populous and economically important territory.

An appendix in **NBC Scenarios** describes an actual EMP threat made by Vladimir Lyukin, leader of an official delegation of the Russian Duma, to an official delegation of the U.S. Congress during negotiations in Vienna over the Yugoslavian crisis in 1999: "What Lyukin said was, if we really wanted to hurt you, we would launch an SLBM from the sea…and we would detonate the weapon at high altitude, create an EMP effect, which would shut down your country for a month or two."[61]

Another unclassified study by the Defense Threat Reduction Agency, published in April 2001, posits several further scenarios involving EMP attack, where EMP is either the primary lethal effect or a secondary "bonus" effect. **High-Altitude Nuclear Detonations (HAND) Against Low Earth Orbit Satellites ("HALEOS")**, the DTRA study, is concerned that a nuclear detonation above the atmosphere could destroy satellites in low Earth orbit (LEO) that are commercially and militarily critical to the United States:

- "LEO satellite constellations will be of growing importance to government, commercial, and military users in coming years."

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[59] Ibid.
[60] Ibid, pp. 156-157.
[61] Ibid, pp. 158-159.

- "Proliferation of nuclear weapons and longer-range ballistic missile capabilities is likely to continue."
- "One low-yield (10-20 kt), high-altitude (125-300 km) nuclear explosion could disable—in weeks to months—all LEO satellites not specifically hardened to withstand radiation generated by that explosion."[62]

The **"HALEOS"** study suggests numerous generic scenarios for a high-altitude nuclear attack, including "regional nuclear war," a "nuclear warning shot in a regional conflict," an "effort to damage adversary forces/infrastructure with electromagnetic pulse," or as an attempt to save the warhead from missile defenses by "salvage fusing" when intercepted. According to the DTRA study, a high-altitude nuclear attack could also be a "deliberate effort to cause economic damage with lower likelihood of nuclear retaliation." Such an attack might be executed by a "rogue state facing economic strangulation or imminent military defeat" or in order to "pose an economic threat to the industrial world without causing human casualties or visible damage to the economic system," according to the study.[63]

DTRA's **"HALEOS"** study postulates two detailed military-political scenarios involving high-altitude nuclear detonations that would damage satellites and produce EMP as "collateral damage from a warning shot":

> *Truck bomb kills most of India's command echelon in Kashmir. India announces large military exercises near India-Pakistan border. Pakistan mobilizes its reserves, including special weapons; missile regiments disperse into the field. Indian armor crosses the Pakistan border. Pakistan fires a medium-range missile that detonates a nuclear warning shot over New Dehli at night, high enough (300 km) to reduce ground effects, yet clear enough to "bring India to its senses." Altitude of detonation enhances damage to LEO constellations.*[64]

In the second "HALEOS" scenario, the DTRA study posits a high-altitude nuclear detonation as "deliberate use or salvage fused intercept" during a conflict on the Korean peninsula:

> *North Korean army coup/revolt, civil war ensues. Units loyal to Kim Jong-Il control missile/nuclear forces. ROK forces launch air strikes against northern missile sites; U.S. forces deploy for an aerial campaign against North Korean NBC assets. As ROK, U.S., and/or coup forces threaten to close down launch sites, nuclear-tipped Taepo Dong missile(s) launch, in Kim Jong-Il's final*

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62 Defense Threat Reduction Agency, High Altitude Nuclear Detonations (HAND) Against Low Earth Orbit Satellites ("HALEOS") (April 2001), p. 4.

63 Ibid, p. 5.

64 Ibid, p. 6.

gesture of defiance toward the West. Warhead detonates on the ascent—or is intercepted and detonates—at 120 to 150 km altitude.[65]

All of DTRA's scenarios for high-altitude nuclear detonations, including those aimed primarily against space satellites, would produce EMP damaging to military and civilian systems on Earth.

Academic literature is also replete with plausible scenarios for EMP attack. For example, "The Threat of High Altitude Electromagnetic Pulse to Force XXI" (Sean J. A. Edwards, **National Security Studies Quarterly**, Autumn 1997) argues that EMP attack is the best nuclear option for Third World states that must confront the technologically superior U.S. Army of the 21st century.[66] Whereas most EMP scenarios are aimed at U.S. air, naval or space assets, the EMP attack postulated in **NSSQ** is aimed at making the high-tech U.S. Army vulnerable to Third World conventional forces:

There are two main reasons why a nascent nuclear power would be willing to use one of its precious nuclear weapons for a HEMP attack. First of all, it is the best asymmetric strategic choice in a regional crisis where an adversary's conventional forces are arrayed against U.S. forces. The HEMP-conventional attack offers a chance for a quick victory while avoiding any serious risk of U.S. nuclear retaliation. Second, the U.S. Army will become increasingly more vulnerable to HEMP….A costly battle that inflicts casualties on U.S. forces might raise the costs of intervention above a level considered acceptable for Americans. The trick is to achieve a "Tet Offensive" or "Mogadishu" reaction, not a "Pearl Harbor" reaction.[67]

The NSSQ article contends that a Third World state could combine an EMP attack with an attack by its conventional forces to achieve victory without provoking U.S. nuclear retaliation:

A symmetric strategy like a conventional attack has no hope for success against a Force XXI Army with information dominance. Asymmetric strategies which directly use weapons of mass destruction (WMD), such as dropping a fission bomb directly on U.S. troops, would backfire and anger the American public, and probably provoke a devastating U.S. nuclear response….An adversary's best option is to avoid using nuclear weapons directly on U.S. troops and instead employ them as a sort of massive electronic warfare tool to beat the United States at its own game. By integrating a HEMP attack on U.S…(C4I) assets with a conventional attack on the projected U.S. forces in the region, a U.S. adversary would stand a good chance of inflicting heavy

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65 Ibid, p. 7.

66 Sean J. A. Edwards, "The Threat of High-Altitude Electromagnetic Pulse to Force XXI," **National Security Studies Quarterly** (Autumn 1997).

67 **NSSQ**, op. cit., p. 62.

casualties on a deaf and blind American force, ill prepared to fight without its information and communication advantages.[68]

A Heritage Foundation study, **America's Vulnerability to A Different Nuclear Threat: An Electromagnetic Pulse** (Jack Spencer, May 26, 2000), like the **NSSQ** article, also concludes that, "The motivation for a rogue state to use its limited nuclear arsenal in an EMP strike against the United States is simple: It maximizes the impact of its few warheads while minimizing the risk of retaliation." Further, "Because EMP attacks are less risky…such attacks are far more likely to occur in this era of nuclear proliferation than they were at any time during the Cold War."[69]

The Heritage Foundation describes five possible scenarios for EMP attack:

- Scenario #1: A rogue state leader decides to launch an EMP attack on the United States to improve the odds of winning a regional conflict. After obtaining an ICBM equipped with a nuclear warhead, Saddam Hussein decides to invade Kuwait again. The United States is called upon to liberate its ally. A few weeks into the war, Saddam launches a ballistic missile armed with a nuclear warhead toward the United States. It is detonated 50 miles above a section of the American West. Although no people are harmed, there is a regional blackout. Saddam…weaken[s] U.S. resolve by demonstrating his ability to deliver a nuclear weapon to U.S. soil. The President refuses to launch a counter nuclear attack out of fear that it would kill millions of innocent people.
- Scenario #2: An enemy explodes a nuclear device over a theater of combat or an area containing allied assets to cripple the United States. North Korea decides to take South Korea but faces 37,000 U.S. troops stationed there. It explodes a nuclear device over the extreme southern part of the Korean peninsula. The EMP effect covers all of Korea, with the strongest effects occurring below the demilitarized zone. North Korea's military is harmed, but the damage is far less severe than that experienced by U.S. and South Korean forces since they rely on modern electronics to a much greater extent. Because the U.S. and allied forces are unable to utilize their advanced radar, communications, and networked systems, they suffer a major decline in war fighting capabilities. Electronic systems on a carrier battle-group on its way to the Korean theater are damaged as well. As a result, the United States is seriously constrained in responding to a North Korean attack across the demilitarized zone.
- *Scenario #3: A surprise terrorist attack is launched against the United States, but the aggressor cannot be identified.* An unknown aggressor launches a ballistic missile with a nuclear warhead from a ship located at sea 150 miles east of New York City. The device explodes 80 miles above New York, spreading its effect over most of New York and Pennsylvania. Wall Street shuts down, massive traffic tie-ups occur throughout the metropolitan region, and air traffic control systems are severely degraded. The crew of

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[68] Ibid, pp. 62-63.

[69] Jack Spencer, **America's Vulnerability to a Different Nuclear Threat: An Electromagnetic Pulse**, Backgrounder No. 1372 (Washington, D.C.: Heritage Foundation, 2000).

the ship immediately abandons the vessel and sinks it, and no one admits responsibility. Analysis leads the U.S. Government to believe that the missile was probably a Scud variant, but because the United States cannot identify who launched it, there is no basis for retaliation.

- *Scenario #4: An enemy uses an EMP blast as part of its war strategy against a U.S. ally.* Suppose China commences another military exercise in the Taiwan Strait. As part of the exercise, it launches a ballistic missile in a trajectory over Taiwan. When the missile reaches 300 miles southeast of Taiwan, its nuclear warhead is detonated, releasing an EMP that affects the entire island. The ensuing blackout incites mass confusion and seriously degrades the war fighting ability of the Taiwanese military. Taiwan is unable to defend itself and is forced either to sue for peace with the mainland or to call in the United States to defend it from attack.
- *Scenario #5: A rogue leader wants to attack the United States but evade retaliation.* Iran, which the 1998 Commission to Assess the Ballistic Missile Threat to the United States (the Rumsfeld Commission) reported "has the technical capability and resources to demonstrate an ICBM-range ballistic missile ….within five years of the decision to deploy," decides to take hostile action against the United States after developing an ICBM. It knows that a direct nuclear attack on the United States would result in the destruction of Teheran. It launches two missiles with nuclear warheads that detonate 250 miles above Illinois and Wyoming. The United States does not retaliate because no one is immediately killed. Not knowing whether Iran has other nuclear warheads, the United States decides to limit its response against Iran rather than risk a direct nuclear attack on a U.S. city.[70]

One can speculate endlessly, and the literature does, on the circumstances wherein an adversary might consider executing an EMP attack. Such scenarios are useful, as in all threat analysis, as they help policy makers and defense planners gauge the plausibility of the threat. Equally important, anticipating the range of circumstances and particular circumstances for a threat is indispensable for defense preparedness, and is necessary, though not necessarily sufficient, to avoid surprise.

Eleven generic scenarios provide a framework for thinking about the circumstances that might lead to an EMP attack. These scenarios encompass all of those in the copious literature on EMP that have been described, and some that have not:

- *EMP attack against U.S. strategic C3 and nuclear forces to debilitate the United States' nuclear retaliatory capabilities.* This was the chief scenario for EMP attack during the Cold War, and is still relevant today. According to unclassified U.S. reports and Soviet sources, the Soviet Union planned, in the event of nuclear war, to make multiple EMP attacks employing a combination of ICBMs and forward-deployed SLBMs. This precursor to a massive counterforce attack was intended to prevent or slow the execution

[70] Ibid.

of U.S. ICBMs and bombers so that they could be destroyed before launching. The Soviets probably also hoped that an EMP attack would impede the operation of U.S. SSBNs and other naval forces at sea by degrading their CONUS-based C3.[71] According to an unclassified briefing on the Nuclear Posture Review by the Department of Defense, as deep reductions in the strategic nuclear forces of the United States progresses, the prompt and reliable operation of C3 becomes increasingly important as a force multiplier. This could make EMP attack an increasingly attractive option to the Russians. Russia almost certainly retains some variant of its Cold War plans for an EMP attack. China, although its core nuclear strategy appears to be a counter-population attack against U.S. cities, might try a small EMP attack, using perhaps one missile, gambling that it might significantly degrade U.S. strategic C3 and forces.

- *EMP attack against U.S. general purpose forces in CONUS.* North Korea, Iran, Iraq or another adversary engaged in a theater conventional war with the United States might calculate that an EMP attack against U.S. conventional forces in CONUS would be the most effective option, militarily and strategically. U.S. plans for theater war assume that the United States will be able to reinforce its forward deployed ground, air, and naval forces from other theaters and especially from the United States. An EMP attack could be made early in a crisis or conflict, against those military forces or logistical assets—like airlift capabilities—intended to reinforce the theater from bases in the United States. Such an EMP attack might cut-off U.S. theater forces from their reinforcements, leaving them alone, or inadequately reinforced, to face the adversary. Moreover, the experience of recent wars has shown that some of the most effective U.S. military systems that can be brought to bear on a theater would operate out of CONUS. For example, during operation ALLIED FORCE against Yugoslavia, the single most effective U.S. weapons platforms were the B-2 bombers flying intercontinental missions from Whiteman Air Force Base in Missouri.
- *EMP attack against U.S. and allied general purpose forces in a theater.* An EMP attack could support a general offensive against U.S. and allied forces on the battlefield. In South Korea, the Middle East, and Taiwan, U.S. and friendly forces actually present are vastly outnumbered by the potential adversary. For example, on the Korean peninsula, North Korea's million-man army and 5,000 tanks is opposed by 37,000 U.S. troops. Even counting South Korean forces, the U.S. and R.O.K. allies are outnumbered in most categories by more than 2-to-1.[72] The odds are far worse than this in the Middle East, where the normal U.S. presence in or near Kuwait and Saudi Arabia, combined with local allied and friendly forces, are outnumbered by Iraq or Iran by better than 5-to-1. An adversary might calculate that an EMP attack against U.S. and allied forces in the theater would enable him to more successfully exploit his local numerical preponderance and achieve a quick victory. An adversary might also calculate than an EMP attack is the

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[71] Peter Vincent Pry, **Nuclear Wars: Exchanges and Outcomes** (Washington, D.C. and London: Crane Russak, 1990), pp. 24-27. HASC Hearing (7 October 1999), op. cit., p. 77.

[72] North Korea Advisory Group, op. cit., pp. 23-32.

only way of achieving battlefield victory, or stalemate, against the high-tech U.S. military after reinforcements have arrived in the theater. U.S. aircraft carriers, viewed by potential adversaries as the backbone of U.S. power projection capabilities, would be high on the list of potential targets for an in-theater EMP attack.

- *EMP attack against the United States civilian infrastructure*. An EMP attack might be aimed deliberately at the U.S. civilian population for coercion or revenge. The effectiveness of an EMP attack is most problematical against strategic forces and C3 (that have received the most hardening), less problematical against general purpose forces (that have received some hardening), and least problematical against civilian infrastructure (that has received the least hardening). An EMP attack is sure to cause some damage against U.S. civilian infrastructure. Indeed, such an attack could conceivably inflict catastrophic, non-recoverable destruction. At minimum, large areas of the United States would be without power and communications for a protracted period, probably lasting at least days or weeks.[73] An adversary might prefer the certainty of damaging the U.S. civilian infrastructure over riskier attacks, of less certain consequence, against U.S. military forces. The objective of such an attack might be, during a conflict, to make the economic and domestic political price of the war so high for the United States that it would abandon the effort, as in Somalia, or negotiate a losing peace, as in Vietnam. Such an attack might also be calculated to permanently alter U.S. foreign policy by turning the American people against internationalism and toward an isolationist "fortress America" mentality. Aggressors could then pursue their long-term regional objectives with less risk of U.S. intervention. Vengeance should not be underestimated as a possible motive for an EMP attack on U.S. civilians. An adversary like Iraq's Saddam Hussein or North Korea's Kim Jong-Il is not likely to survive losing a war to the United States, and may want to inflict the greatest possible injury on the greatest possible number of his enemies.
- *EMP attack against allied civilian infrastructure.* In a war where the United States' military effort depends upon a coalition of allies, an adversary might try breaking the coalition by making an EMP attack against the civilian infrastructure of one or more U.S. allies. The objective would be to turn one or more U.S. allies against the war by making the cost of continuing the conflict, in the view of U.S. allies, not worth the effort. In most imaginable major wars that could occur overseas, the United States would require the political and military support of its allies. An adversary may believe, with some justification, that it is easier to break the will of U.S. allies than to test the will of the United States itself. During the 1991 Persian Gulf War, Saddam Hussein attempted a modest version of this strategy by making missile attacks on Israeli cities, hoping to provoke retaliation from Israel, and so destabilize the U.S.-Arab allied coalition confronting Iraq in the Persian Gulf. The United States expended considerable diplomatic and military effort, including deploying Patriot anti-missile batteries to Israel, to dissuade Israeli retaliation and to preserve the allied coalition. An EMP attack would be far more injurious and threatening to U.S. allies, and to the cohesion of a U.S.-led

[73] HASC Hearing (7 October 1999), op. cit., p. 78.

coalition, than Iraq's militarily ineffectual, but politically potent, missile attacks on Israel in 1991.

- *EMP attack for salvage fusing.* An adversary concerned that his missiles might be intercepted by defenses *en route* to target might fuse his nuclear warheads to detonate, should interception occur. Since interception of a ballistic missile is most likely to occur at high-altitude, the detonating warhead would produce an EMP attack that might still reach the intended target, or other targets of value. Salvage fusing of warheads for EMP attack might at least degrade U.S. ballistic missile defenses, and make penetration of those defenses by later missile attacks more likely. Salvage fusing for EMP attack is likely to be an attractive option for actors having small numbers of missiles and nuclear weapons as, in effect, an insurance policy against the complete loss of these valuable assets. Salvage fusing for EMP attack might also be employed as a back-up option should the missile fail for mechanical reasons during flight at high altitude. Such failures have been a common feature during flight-tests of the primitive missiles deployed and under development by such states as North Korea and Iran.
- *EMP attack as a "warning shot."* An EMP attack could be performed during a crisis or conflict to exploit U.S. and international fear of nuclear weapons in order to achieve a favorable outcome. The democratic international community perceives a vital interest in preserving the longstanding non-use of nuclear weapons in war. Confronted with an EMP "warning shot," many U.S. allies, and many U.S. citizens, might prefer that the United States yield in a crisis or war, rather than risk further nuclear escalation. The more nuclear weapons are used, the greater their legitimacy as military instruments. Many would consider preserving the "illegitimacy" of nuclear weapons a goal more important than virtually any regional interest. An EMP "warning shot" during a crisis or war, accompanied by a "peace offensive" by the perpetrator, would be sure to gain at least some international support for a negotiated solution. The United States, even if acting independently of allies, might be dissuaded by such a threat. For example, suppose China makes an EMP attack on an aircraft carrier group coming to the support of a threatened Taiwan, warning the United States that mutual nuclear annihilation is in the offing, unless a new political status for Taiwan can be negotiated. The United States would have to weigh its interests in Taiwan against, for example, the survival of Los Angeles and perhaps 14 additional U.S. cities. The EMP "warning shot" would make more credible China's escalatory threat, and increase the chances for successful "nuclear blackmail."
- *EMP attack as a result of miscalculation.* A potential adversary may mistakenly believe, based on false intelligence, that the United States is about to strike with nuclear or advanced conventional weapons, and so launch an EMP attack to preempt the impending "U.S. aggression." EMP attack would be a particularly attractive option if the adversary had some uncertainty about his intelligence indicating an imminent U.S. threat. EMP would disrupt U.S. forces and warn Washington against aggression—if aggression is contemplated—but inflict the least number of casualties on U.S. forces, if the intelligence

proves false. This scenario for an EMP attack may sound outlandish, but could be the most likely. False warning has on several occasions misled Russia to go on nuclear alert, including as recently as January 1995, in mistaken overreaction to a Norwegian meteorological rocket.[74]

- *EMP attack as a "bonus" to an anti-satellite operation.* An adversary might calculate that the most militarily effective option would be to degrade or destroy U.S. low-orbiting satellites with a high-altitude nuclear detonation. Under this scenario, EMP attack would be secondary to the attack against satellites. A high-altitude nuclear detonation could greatly intensify trapped radiation in the Van Allen belts and, over weeks to months, disable all low-orbiting satellites that are not hardened against such effects. Satellites are a key technology in U.S. plans for "transformation" of the military into a force capable of winning wars through "information dominance" and "networking" of intelligence, communications, and battle management systems. In practical terms, without satellites, the United States' capability to collect intelligence, communicate, target, and coordinate military operations would be seriously degraded. A high-altitude nuclear detonation aimed against satellites would also generate EMP that could degrade U.S. and allied forces or civilian infrastructure.[75]
- *EMP attack between other parties.* An EMP attack during a war between other nations, not involving the United States, could nonetheless threaten U.S. assets, forces, or allies. For example, nuclear war could arise between India and Pakistan, China and India, Russia and China, [redacted] and Iraq or Iran or other combinations. As missiles and nuclear weapons proliferate, the possibilities for EMP attacks between other parties will multiply. The detonation of a nuclear weapon in space for EMP could damage or destroy U.S. satellites, assets valued at $50 billion, even if the United States is not the intended target. U.S. and allied forces or assets could be damaged if they are located on the periphery of an EMP field, typically hundreds or thousands of kilometers wide, even if the EMP attack is targeted at another party. [redacted]. A Pakistani EMP attack on Israel—Pakistan suspects Israel is an ally of India—could damage U.S. forces in the region and Israel, a valuable U.S. ally. Another possibility is that the losing party in a war not involving the United States could threaten to perform an EMP attack, knowing this would also threaten U.S. space assets, in order to leverage the United States to intervene and press for a negotiated solution to the conflict.
- *Inadvertent EMP Event.* Rogue state sophistication in nuclear weapon design and safety technologies is not well understood. Early U.S. nuclear weapon designs had no or poor safety mechanisms, posing a risk of inadvertent detonation. It is conceivable that a rogue state nuclear weapon could detonate accidentally. Catastrophic failure of a rogue state nuclear missile, not necessarily aimed at the United States or U.S. forces, could nonetheless trigger a nuclear detonation at high altitude, generating an EMP event

[74] **War Scare**, op. cit., pp. 185-238.
[75] HASC Hearing (7 October 1999), op. cit., pp. 67-68. Defense Threat Reduction Agency, op. cit., passim.

injurious to the United States, U.S. forces, or allies. U.S. missile defenses intercepting a rogue state warhead could also conceivably trigger an accidental nuclear detonation and an inadvertent EMP event.

Each of the above scenarios is likely to involve significant operational differences in targeting and timing of the EMP attack. For example, an EMP attack on the United States against strategic nuclear forces would probably target the peak EMP field or fields against command and control centers, ICBM wings, or bomber bases. An EMP attack against U.S. general purpose forces in CONUS would probably target the peak EMP field or fields against their key bases, such as the B-2s at Whiteman Air Force Base, aerial tankers at Barksdale Air Force Base, or an aircraft carrier and its supporting elements at Norfolk. An EMP attack against U.S. civilian infrastructure might target one or both coasts of the United States, where most of the population is located. An EMP attack mainly for political purposes, as a "warning shot," might target a national capital, like Washington, D.C., or a geographically remote but politically important area, like Alaska or Hawaii.

The burst height of an EMP attack is likely to vary with scenario. For example, if the goal is to kill many targets, burst height may be higher to increase the area covered by the EMP fields. Against a single target or cluster of targets, especially if the targets are EMP hardened, the burst height may be lower to make a more powerful peak EMP field. In a theater of operations, burst height and location may be determined by the need to maximize damage to U.S. and allied forces, while limiting collateral damage to the adversary's own forces.

The timing of an EMP attack is also likely to vary with scenario. For example, an EMP attack might be made early in a conflict to support surprise or preemptive operations by nuclear or general purpose forces. An EMP attack in the middle of a war could support ongoing battlefield operations. An EMP attack late or at the end of a war might be to thwart efforts at reconstitution and recovery from an earlier EMP attack, or might be a last-ditch military or political act of desperation, or for revenge.

Some may argue that state or non-state actors would not dare violate the longstanding international norms against employing nuclear weapons—even for an EMP attack—under any conceivable scenario. It is well to remember that the United States, arguably the world's most humanitarian nation, is also the only nation ever to use nuclear weapons, so far. Today, most Americans still agree that the United States Government's decision to drop atomic bombs on Hiroshima and Nagasaki in 1945 was, under the circumstances, militarily and morally right. The political norms of North Korea, Iraq, Iran and other such states are surely no guarantee against any nuclear scenario conceivable, including EMP attack.

More recent history also suggests that nuclear war is a plausible scenario, and perhaps especially EMP attack. According to press reports, [redacted]

[redacted]

[redacted] widely reported in the world press as true, however inaccurate or apocryphal, has certainly been noted by Iraq and other potential adversaries.

[redacted]